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Boston Transit Commission.

Eighth Annual Report.



August 15, 1901.

to

June 30, 1902.

No

6355. ✓



GIVEN BY

Estate of James B. Noyes

FROM

THE BOSTON TRANSIT COMMISSION,

20 Beacon Street.

GEORGE G. CROCKER, *Chairman,*

CHARLES H. DALTON,

GEORGE F. SWAIN,

THOMAS J. GARGAN,

HORACE G. ALLEN,

Commissioners.

HOWARD A. CARSON,

B. LEIGHTON BEAL,

Chief Engineer.

Secretary.



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EIGHTH ANNUAL REPORT

OF THE

BOSTON TRANSIT COMMISSION,

FROM

AUGUST 15, 1901,

TO

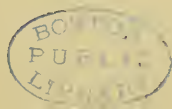
JUNE 30, 1902.



BOSTON

ROCKWELL AND CHURCHILL PRESS.

1902



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Vol. 8

Estate of James B. Royce
December 30, 1949

BOSTON TRANSIT COMMISSION.

20 BEACON STREET, BOSTON, June 30, 1902.

TO THE CITY COUNCIL OF THE CITY OF BOSTON :

In compliance with Statutes of 1894, chapter 548, section 24, the report of the Boston Transit Commission for the period from Aug. 15, 1901, to date, is respectfully submitted.

EAST BOSTON TUNNEL.

The progress of the work on the East Boston tunnel is described in detail in the report of the Chief Engineer.

Section B, which extends from a point in East Boston under Lewis street near Webster street to a point under State street a short distance west of Atlantic avenue, has been completed to a point under the harbor about midway between the Harbor Commissioners' lines ; 2260 feet remain to be built, together with a portion of the Atlantic avenue station.

A fence similar to that in the Public Garden has been erected in Maverick square.

Soon after the date of the last report it appeared that a portion of the basement of the Old State House would be needed for the purposes of the East Boston tunnel, and the following communication was sent to His Honor the Mayor :

BOSTON TRANSIT COMMISSION,
20 BEACON STREET, BOSTON, Nov. 21, 1901.

HON. THOMAS N. HART, *Mayor* :

DEAR SIR: I am instructed by the Commission to suggest to you that, inasmuch as the basement of the Old State House will probably be required for a station for the East Boston tunnel, it would be unwise for the city to make any long lease of the same.

Yours very truly,

(Signed)

GEORGE G. CROCKER,
Chairman.

Many studies and plans for that portion of the tunnel from the Atlantic avenue station west to Scollay square have been considered by the Commission and discussed with the officials of the Boston Elevated Railway Company.

It seemed advisable to delay final action upon that portion of the tunnel which might be affected by the building of a new subway or tunnel, until after the action of the Legislature with reference thereto.

On Feb. 25, 1902, bids were opened for the construction of Section C, from India street to near Atlantic avenue, all of which were rejected. The work has since been carried on upon a percentage basis and at lower figures than any which were offered by the bidders. The work is still in progress under this arrangement.

SUBWAY.

Ventilation.

Several complaints having come to the Commission in regard to the impurity of the air in the subway and in the cars therein, a letter was sent to the Boston Elevated Railway Company on Oct. 3, from which the following is an extract :

Several complaints have recently come to our knowledge in regard to the impurity of the air in the subway and in the cars therein.

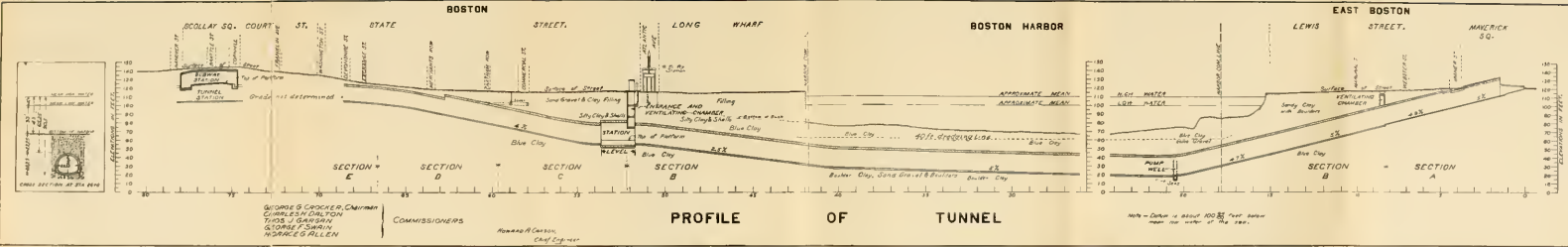
Will you please send us a statement as to the number of fans installed, their location and capacity and the extent to which they are operated ? Also whether any of them are used to draw in the air instead of exhaust it ?

On Oct. 5 the president of the company in a letter relating to various subjects made the following reply to the foregoing questions :

I beg to say in response to your inquiries concerning the fans in the subway that we have five fans installed, one at the Boylston street end, two at West street, and two at Eliot street. The one at Boylston street is represented to have a capacity of about 50,000 cubic feet per minute ; those at West and Eliot streets a capacity of 74,000 cubic feet per minute, at 175 revolutions. At this moment I am advised but one is in operation. The motors which were supplied for this purpose by the contractor have proved unsatisfactory in operation and the contractor now has them at his works to remedy the defects.

It is believed that the ventilating chambers which have been provided are sufficient, if equipped with proper fans, to keep the atmosphere in a satisfactory condition.

When the subway was built, the ventilating chamber, which according to the plans was to be located at the corner of Hanover and Washington streets, was left uncompleted to await the adoption of plans for the then contemplated connection between the East Boston tunnel and the subway



at this point. After the route of the tunnel to and under State street was determined upon, on October 3, the Chief Engineer was instructed to complete this chamber. The work was completed December 21, its cost being \$3,362.65.

The Cost of Removing and Relocating Underground Structures.

In the Fifth Annual Report, pages 12 and 13, is given a statement as to the controversy which arose between the Commission and companies owning underground structures in the streets as to the payment of the cost of the removal and relocation of such of those structures as interfered with the subway. The cost was ultimately paid by the Commission in order to avoid delay in the work, and subsequently suits were brought for the recovery of the cost and the determination of the questions at issue. On Feb. 28, 1902, a decision was rendered in the Supreme Court in the suit against the Boston Electric Light Company (see Appendix A), giving judgment for the Commission. Before the hearing of this case it had been agreed by the Edison Electric Illuminating Company and by the New England Telephone and Telegraph Company that the suits against them should be determined by the result of that against the Boston Electric Light Company.

The amounts recovered were as follows :

Boston Electric Light Company	\$1,271.90
Edison Electric Illuminating Company	4,653.24
New England Telephone and Telegraph Company	7,644.74
	<hr/>
	\$13,569.88

Of this total the sum of \$1,650 was paid for counsel fees, and of the balance \$10,464.40 was credited to the subway account and \$1,455.48 to the account for alterations, reducing the net cost of the subway and alterations by the sum of \$11,919.88.

The suits against the gas companies are pending.

Miscellaneous.

With the instalment of the elevated service of the Boston Elevated Railway Company and the re-arrangement of its surface tracks at the northern terminus, the Causeway street shelter ceased to be of use and it has been removed by the company, the main structural parts being stored in case it should become desirable to put them again in service.

An iron fence similar to that in the Public Garden has been erected at the northern incline at a cost of \$938.27.

A temporary wooden canopy over the platforms at the Pleasant street station and a snow shed at the northern incline have been erected by the Boston Elevated Railway Company, with the consent of the Commission.

Permission has been granted to the Boston Elevated Railway Company to erect an emergency building on the land bounded by Causeway and Canal streets and the former line of Traverse street, provided the assent of the proper city authorities is obtained, the company agreeing that it will remove the same upon the termination of the present lease of the subway, or of any renewal or extension thereof, and that upon failure so to do the building shall become the property of the city of Boston.

The sidewalk of the Pleasant street entrance to the subway is to be put in permanent form, the cost thereof being made a part of the cost of the subway by assent of the Boston Elevated Railway Company.

The amount expended on the subway account during the period covered by this report has been \$4,904,84, of which \$3,362.65 was for the ventilating chamber at the corner of Washington and Hanover streets and \$938.27 for the fence at the northern incline.

CHARLESTOWN BRIDGE.

The amount expended for Charlestown bridge during the period covered by this report was \$10,176.45, of which \$8,643.65 was for land and grade damages, and \$1,393.18 for a pier landing, the finishing of the pier landing concluding the work of construction of the bridge and its approaches and surroundings. All questions of damages for taking land or changing grades have been settled, and the only work remaining for the Commission in connection with the bridge is the disposition of the parcel of land bounded by Charlestown bridge, Chamber, and Water streets, containing 6,833 square feet.

The cost of the bridge to date has been \$1,562,712.88.

LEGISLATION.

The Legislature of 1902 passed two acts affecting the work of the Commission. The first was chapter 114, which provides that the East Boston tunnel and the Cambridge street subway, with the consent of the Boston Elevated Railway Company, may be connected with the existing subway and

with each other and with any other subway on such terms and in such manner and at such points either at grade or otherwise as the Commission may deem that the public interests require. (See Appendix B.)

Chapter 534 provides for the construction of additional tunnels and subways in the city of Boston. (See Appendix C.) By said act the term of the Commission was extended to July 1, 1904, or in case of the acceptance of the act by the voters of the city, to July 1, 1906.

SINKING FUNDS.

The following is the condition of the debt and sinking funds for the various appropriations for the work of the Commission, at the date of this report:

SUBWAY (INCLUDING ALTERATIONS).

(Debt, \$4,416,000, outside debt limit.)

Amount of Fund, Aug. 15, 1901	\$468,057 57
Interest on Bank Deposits, Aug. 15, 1901, to date	\$476 03
Interest on Investments, Aug. 15, 1901, to date	12,136 75
Revenue received, Aug. 15, 1901, to date	42,994 62
	<hr/> 55,607 40
	<hr/> <u>\$523,664 97</u>

CHARLESTOWN BRIDGE, No. 1.

(Debt, \$750,000, inside debt limit.)

Amount of Fund, Aug. 15, 1901	\$61,410 63
Interest on Bank Deposits, Aug. 15, 1901, to date	\$155 61
Interest on Investments, Aug. 15, 1901, to date,	1,283 40
Revenue received, Aug. 15, 1901, to date	1,800 00
Requirement for debt	8,845 00
	<hr/> 12,084 01
	<hr/> <u>\$73,494 64</u>

CHARLESTOWN BRIDGE, No. 2.

(Debt, \$805,000, outside debt limit.)

Amount of Fund, Aug. 15, 1901	\$74,330 57
Interest on Bank Deposits, Aug. 15, 1901, to date	\$301 22
Interest on Investments, Aug. 15, 1901, to date,	1,364 62
Requirement for debt	7,928 00
	<hr/> 9,593 84
	<hr/> <u>\$83,924 41</u>

EAST BOSTON TUNNEL.

(Debt, \$1,285,000, outside debt limit.)

Premium on Loan issued	\$21,600 00
Amount of Fund	<u>\$21,600 00</u>

AMOUNTS PAID FOR RENTAL OF THE SUBWAY.

The following sums have been paid during the year by the Boston Elevated Railway Company for the use of the subway :

Sept. 30, 1901 :

Net cost of subway	\$4,138,490 80	
One quarter's rental		\$50,437 86
Alterations : total cost	244,218 19	
One quarter's rental		2,976 41

Dec. 31, 1901 :

Net cost of subway	4,139,404 17	
One quarter's rental		50,448 99
Alterations : total cost	245,812 71	
One quarter's rental		2,995 84

March 31, 1902 :

Total cost of subway	4,142,109 23	
Amount recovered from electric companies on account of subway for cost of changing pipes, conduits, etc.	10,464 40	

Net cost of subway	\$4,131,644 83	
One quarter's rental		50,354 42
Alterations : total cost	245,859 03	

Amount recovered from electric companies on account of alterations for cost of changing pipes, conduits, etc. \$1,455 48

Over-charge in previous quarter 1,426 32

2,881 80

Net cost \$242,977 23

One quarter's rental \$2,961 29

Interest at 4 7-8 per cent. for three months on over-charge 17 38

Net rental for one-quarter 2,943 91

June 30, 1902 :

Net cost of subway	\$4,132,772 89	
One quarter's rental		50,368 17
Alterations : total cost	242,977 23	
One quarter's rental		2,961 29

Total \$213,486 89

STATEMENT OF EXPENSES.

The following is a classified statement of the expenses of the Commission for the period ending June 30, 1902:

SUBWAY.

General Expenses:

Stenographer . .	\$6 57	
Office supplies . .	10 34	
	<hr/>	\$16 91

ENGINEERING DEPARTMENT.

Rooms — Supplies	\$51 57	
Stationery and printing, . .	80 00	
Field supplies	3 83	
Labor	233 09	
Skilled service	133 06	
	<hr/>	501 55

SECTION ONE.

Field supplies	\$55 30	55 30
--------------------------	---------	-------

SECTION FOUR.

Construction	\$0 80	
Field supplies	4 28	
Labor	2 33	
	<hr/>	7 41

SECTION SEVEN.

Construction	\$0 40	
Teaming	1 25	
	<hr/>	1 65

SECTION NINE.

Construction	\$1 10	1 10
------------------------	--------	------

SECTION TEN.

Patrick McGovern	\$2,419 48	
Construction	112 80	
Office supplies	5 56	
Field supplies	146 09	
Electric conduits	17 67	
Messenger	1 64	
Stenographer	12 82	
Relocating pipes	44 46	
Teaming	2 25	
Labor	269 88	
Skilled service	330 00	
	<hr/>	3,362 65

SECTION ELEVEN.

Construction	\$907 50	
Inspection	8 33	
Field supplies	4 84	
	<hr/>	
<i>Carried forward</i>	\$920 67	\$3,946 57

<i>Brought forward</i>	.	.	\$920 67	\$3,946 57
Labor	.	.	33 61	
Skilled service	.	.	3 99	
			<hr/>	958 27
Total	.	.		<hr/> \$4,904 84

CREDIT.

During the year there has been recovered from various electric companies, on account of work done in connection with removal and relocation of their underground structures, the net sum of \$11,919.88; of this amount, \$10,464.40 is credited to the subway account and \$1,455.48 to the alterations account. Credit is shown below under the various sections in which the work was performed as follows:

Subway:

Section Three	.	.	.	\$38 32	
" Four	.	.	.	1,253 46	
" Six	.	.	.	124 00	
" Seven	.	.	.	1,962 06	
" Eight	.	.	.	232 37	
" Eight and one-half	.	.	.	76 65	
" Nine	.	.	.	5,229 27	
" Ten	.	.	.	1,485 67	
" Eleven	.	.	.	62 60	
				<hr/>	
Total	.	.	.	10,464 40	
				<hr/>	
Net decrease	.	.	.		\$5,559 56

ALTERATIONS.

(Made upon request of Boston Elevated Railway Company, as authorized by Chapter 500, Acts of 1897.)

General Expenses:

Amount transferred from
East Boston Tunnel general expenses . . . \$1,486 48

Less proportion of general
expenses abated by vote
of Commission, Jan. 16,
1902 . . . \$1,113 82

Also proportion of general
expenses for week of
Dec. 21-28, 1901, abated
by vote of Commission,
Jan. 16, 1902 . . . 10 65

	<hr/>	1,124 47	
	<hr/>	\$362 01	
<i>Carried forward</i>	.	.	<hr/> \$5,559 56

<i>Brought forward</i>	\$362 01	\$5,559 56
Proportion of salary of Chief Engineer	\$416 75	
Less proportion abated by vote of Commission, Jan. 16, 1902	312 50	
	<hr/>	104 25
Office supplies		5 55
Stationery and printing		40 77
		<hr/>
		\$512 58

SECTION FIVE.

Skilled service	\$2 80	2 80
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SECTION SEVEN.

Metropolitan Contracting Company	\$164 92	
Teaming	50	
Labor	48	
	<hr/>	165 90
		<hr/>
		\$681 28

CREDIT.

Amount recovered from electric companies on account of work done in connection with removal and relocation of their underground structures, Section 7, E. P.	1,455 48	
	<hr/>	774 20
Net decrease		<hr/>
Total decrease on subway and alterations		\$6,333 76

DECREASE IN COST OF VARIOUS SECTIONS OCCASIONED BY AMOUNT RECOVERED FROM ELECTRIC COMPANIES.

Subway.	Expended.	Credit.	Net Decrease.
Section Three		\$38 32	\$38 32
Four	\$7 41	1,253 46	1,246 05
Six		124 00	124 00
Seven	1 65	1,962 06	1,960 41
Eight		232 37	232 37
Eight and one-half		76 65	76 65
Nine	1 10	5,229 27	5,228 17
Ten	3,362 65	1,485 67	¹ 1,876 98
Eleven	958 27	62 60	¹ 895 67
	<hr/>	<hr/>	<hr/>
	\$4,331 08	\$10,464 40	\$6,133 32
	<hr/>	<hr/>	<hr/>
Alterations.			
Section Seven	\$165 90	\$1,455 48	\$1,289 58
	<hr/>	<hr/>	<hr/>

¹ Increase.

EAST BOSTON TUNNEL.

General Expenses:

Office — Repairs	\$28 96
Furniture	32 00
Supplies	413 81
Stationery and printing, . .	97 13
Fuel and light	150 59
Rental	1,125 00
Stenographers	2,370 61
Messenger	810 00
Clerks	716 57
Janitor	232 87
Salaries of Commissioners and Secretary	23,330 00

\$29,307 54

Transferred to alterations account, 362 01

Balance General Expenses, East Boston

Tunnel	\$28,945 53
Proportion of salary of Chief Engineer . .	8,229 75

\$37,175 28

ENGINEERING DEPARTMENT.

Rooms — Repairs	\$10 15
Furniture	43 80
Supplies	599 89
Stationery and printing . . .	1,927 81
Fuel and light	147 82
Rental	1,125 00
Janitor	232 88
Messenger	522 43
Stenographers	1,778 20
Clerks	3 43
Instruments	81 20
Skilled service	13,792 15

20,264 76

MISCELLANEOUS.

B. F. Smith & Bro., borings	\$403 53
Teaming	75
Field supplies	34 37
Advertising	34 88
Labor	125 84

599 37

SECTION A.

(In Maverick square and Lewis street, East Boston, to a point 100 feet southwest of Webster street.)

Office supplies	\$0 12
Field supplies	46 32
Construction	1,322 34
Legal and expert advice	75 00

Carried forward \$1,443 78 \$58,039 41

<i>Brought forward</i>	\$1,443 78	\$58,039 41
Inspection	16 67	
Labor	161 24	
	<hr/>	1,621 69

SECTION B.

(From a point in Lewis street 100 feet southwest of Webster street, East Boston, under harbor between South Ferry slip on the East Boston side and Long Wharf on the Boston side, State street.)

Boston Tunnel Construction Company	\$299,699 55	
Construction	16,277 19	
Office supplies	556 90	
Field supplies	940 51	
Labor	1,004 45	
Teaming	41 87	
Legal and expert advice	1,555 40	
Skilled service	1,297 16	
Inspection	6,127 87	
Instruments	97 90	
Rental	235 00	
Water-pipes	305 02	
	<hr/>	328,138 82

SECTION C.

(Under State street, from India street to near Atlantic avenue.)

Gow & Foss	\$9,855 42	
Advertising	134 90	
Field supplies	3,187 56	
Labor	752 01	
Teaming	69 63	
Underpinning	12,320 60	
Inspection	941 59	
Office supplies	181 94	
Electric conduits	227 25	
Stationery and printing	194 00	
Water-pipes	723 03	
Skilled service	36 20	
Instruments	31 70	
Construction	9,635 38	
Rental	20 83	
State street sewer:		
George H. Foss	3,513 82	
Inspection	240 08	
Construction	50 91	
Field supplies	367 06	
Teaming	36 17	
Labor	424 53	
Shaft:		
Gow & Foss	6,258 98	
Field supplies	1,920 84	
Labor	82 75	
Construction	783 52	
Office supplies	1 00	
<i>Carried forward</i>	\$51,991 70	\$387,799 92

SUMMARY.

	From beginning of work to Aug. 15, 1901.	Aug. 15, 1901, to June 30, 1902.	Total.
Subway — Subway Com- mission	\$14,131 16		\$14,131 16
Part of General Ex- penses	117,456 33	\$16 91	117,473 24
Engineering and Miscel- laneous	406,634 01	501 55	407,135 56
Section One	240,596 41	55 30	240,651 71
Two	364,892 05		364,892 05
Three	308,069 53	¹ 38 32	² 308,031 21
Three and one- half	9,479 39		9,479 39
Four	476,586 42	¹ 1,246 05	² 475,340 37
Five	387,439 24		387,439 24
Six	327,618 86	¹ 124 00	² 327,494 86
Seven	236,488 84	¹ 1,960 41	² 234,528 43
Eight	100,111 04	¹ 232 37	² 99,878 67
Eight and one- half	77,467 04	¹ 76 65	² 77,390 39
Nine	309,897 02	¹ 5,228 17	² 304,668 85
Ten	257,401 34	1,876 98	259,278 32
Eleven	269,309 90	895 67	270,205 57
Interest	258,575 60		258,575 60
Total	<u>\$4,162,154 18</u>	<u>¹\$5,559 56</u>	<u>²\$4,156,594 62</u>
Alterations — Part of General Expenses . .	\$28,432 95	\$512 58	\$28,945 53
Section Three	2,568 26		2,568 26
Four	163 42		163 42
Five	30,230 21	2 80	30,233 01
Seven	180,113 99	¹ 1,289 58	² 178,824 41
Nine	3 00		3 00
Ten	534 04		534 04
Interest	1,905 56		1,905 56
Total	<u>\$243,951 43</u>	<u>¹\$774 20</u>	<u>²\$243,177 23</u>
East Boston Tunnel — Part of General Ex- penses	\$69,870 72	\$37,175 28	\$107,046 00
Engineering Expenses .	73,633 03	20,864 13	94,497 16
Section A	93,651 10	1,621 69	95,272 79
B	135,457 81	328,138 82	463,596 63
C		52,874 52	52,874 52
D		10,624 68	10,624 68
Interest	35,175 00	11,725 00	46,900 00
Total	<u>\$407,787 66</u>	<u>\$463,024 12</u>	<u>\$870,811 78</u>
Bridge — Part of General Expenses	\$53,820 57		\$53,820 57
Engineering Expenses .	1,498,715 86	\$10,176 45	1,508,892 31
Total	<u>\$1,552,536 43</u>	<u>\$10,176 45</u>	<u>\$1,562,712 88</u>
Grand Total	<u>\$6,366,429 70</u>	<u>\$466,866 81</u>	<u>\$6,833,296 51</u>

¹ Credit.² Decrease.

By Chapter 375, Acts of 1899, the term of office of the members of the Commission expires with the date of this report. By Chapter 534, Acts of 1902, the term of office of the Commission is extended to the first day of July, 1906, unless that act is not accepted by the voters of the city of Boston at the municipal election in this year, in which case the extended term will continue only until July 1, 1904. By the same act, two members of the Commission are to be appointed by the Governor and three by the Mayor of Boston for a term of two years, the appointments dating from July 1, 1902.

GEORGE G. CROCKER,	} <i>Boston Transit Commission.</i>
CHARLES H. DALTON,	
THOMAS J. GARGAN,	
GEORGE F. SWAIN,	
HORACE G. ALLEN,	

REPORT OF THE CHIEF ENGINEER.

BOSTON, June 30, 1902.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN,
Boston Transit Commissioners:

GENTLEMEN: I submit herewith my report of work on the East Boston tunnel for the past ten and one-half months and on a few minor matters of construction in connection with the subway.

THE EAST BOSTON TUNNEL.

The tunnel has now been substantially completed from where it begins to descend from the surface, in Maverick square, to a point about half way between the South Ferry slip in East Boston and the end of Long Wharf on the Boston side. The total length of nearly completed tunnel is about 2,500 feet and includes Section A and a portion of Section B, both described in last year's report. The advance of the tunnel from northeast to southwest under the harbor from Aug. 15, 1901, to June 30, 1902, has been 1,450 feet. A much greater rate of progress in linear feet has been made in the construction of smaller tunnels, and the progress in hard rock in the Simplon Alpine tunnel has been about four times as great; but these are unlike cases. The only case of a tunnel of equal size worked under compressed air is that of the Blackwall under the Thames, London, alluded to in previous reports. The progress in this tunnel while it was penetrating a clay formation was about the same as that in Section B during the last year and has been considered by all as very creditable work.

The westerly terminus of Section B includes a shaft for the passenger station at the foot of State street just west of Atlantic avenue. If the future progress shall be as rapid as that during the last six months the tunnel will be completed to this shaft by October of next year.

The westerly terminus of the East Boston tunnel as a whole will probably be under the present station at Scollay square, the route thereto lying under State and Court streets. Work on this portion of the tunnel was delayed partly on

account of uncertainty as to the requirements of pending legislation and partly to avoid the loss of interest which would occur on work built a year or more in advance of the time when it could be used. Some work has, however, been done in State street on Sections B, C, and D and a detailed description of this and of that on the sub-harbor portion of Section B appears under appropriate titles in the following pages.

The names of the resident engineer and of the contracting firms are in some cases given in the text. Appendix D gives the names of all assistants who have been employed for more than one month during the last ten and one-half months. Appendix E gives the names of nearly all of the contractors and in some cases of their principal foremen.

SECTION B OF THE EAST BOSTON TUNNEL (CONTRACT WORK).

Contractors for Construction. — The Boston Tunnel Construction Company.

Transit Commission Resident Engineer. — John E. Palmer.

Date of contract.

June 28, 1900.

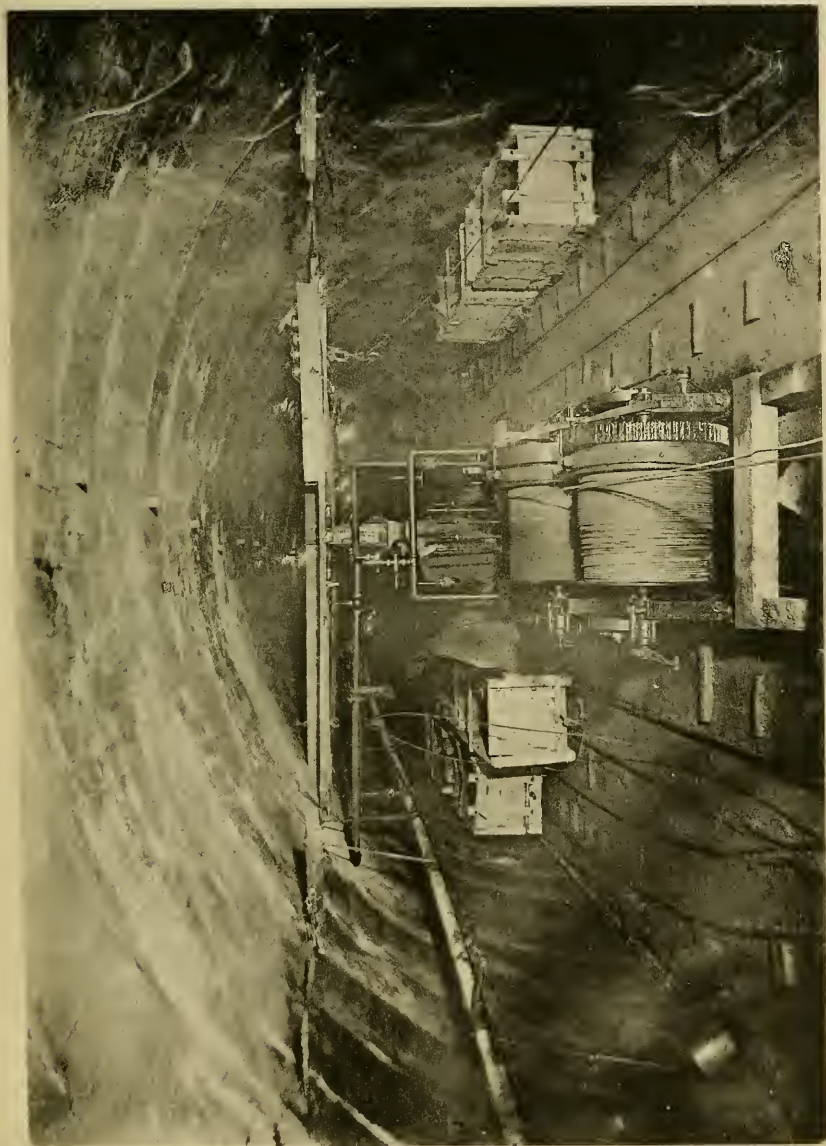
Date of completion
named in contract.

June 15, 1903.

Tunnel Portion.

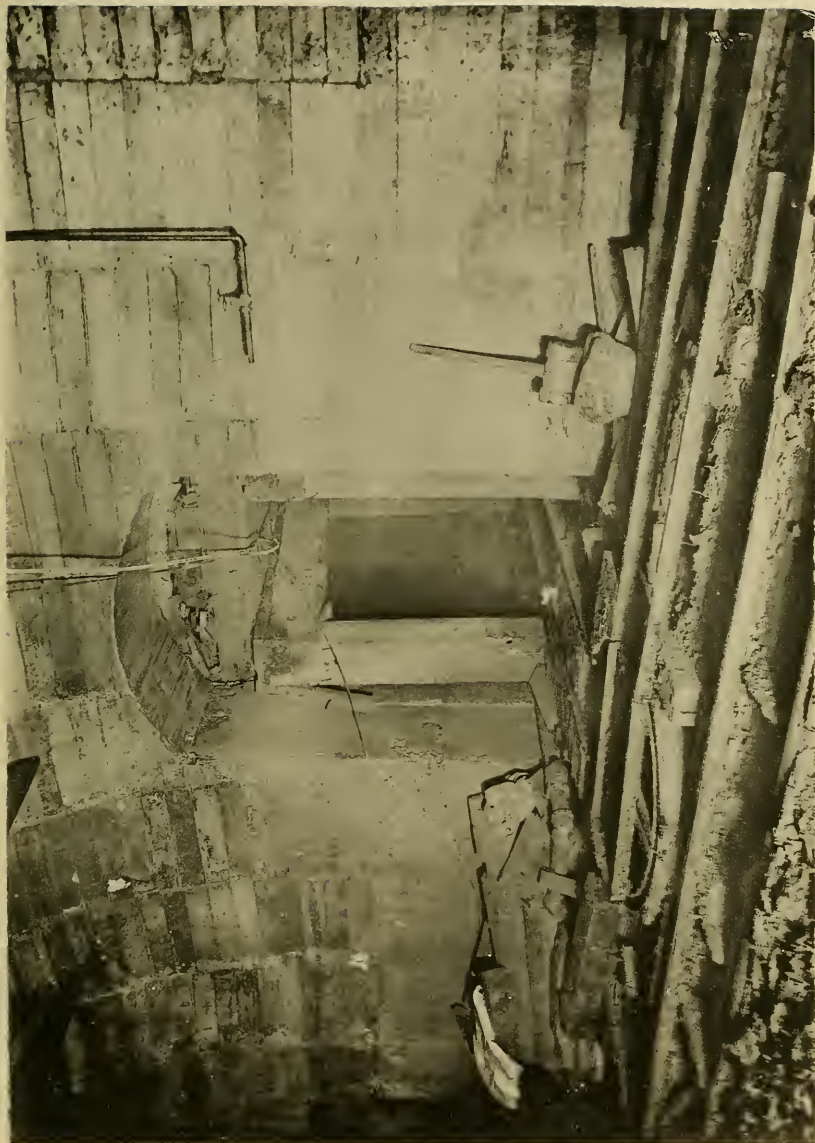
The shape of the structure built during the last year and the methods employed are substantially the same as those described and illustrated in the Seventh Annual Report.

Details of Construction. — During the period covered by this report the tunnel has been driven almost entirely in blue clay containing pebbles. Pockets of sand and gravel have been encountered at intervals. At the deepest point of the tunnel, at the site of the permanent pump-well, a deposit of fine sand was penetrated for a length of about 50 feet which admitted a flow of clear fresh water. About 800 feet farther west a stratum of bowlder clay was met with its upper surface from 1 to 8 feet above the bottom of the tunnel, and excavation is in progress in this at the present time. It contains in addition to the clay, sand, gravel, pebbles, and bowlders, the latter sometimes 5 or 6 feet in diameter. This bed of bowlder clay also admits some water notwithstanding the resistance of the compressed air. Wherever this or a similar stratum occurs the excavation is extended outside the normal lines of the tunnel, and



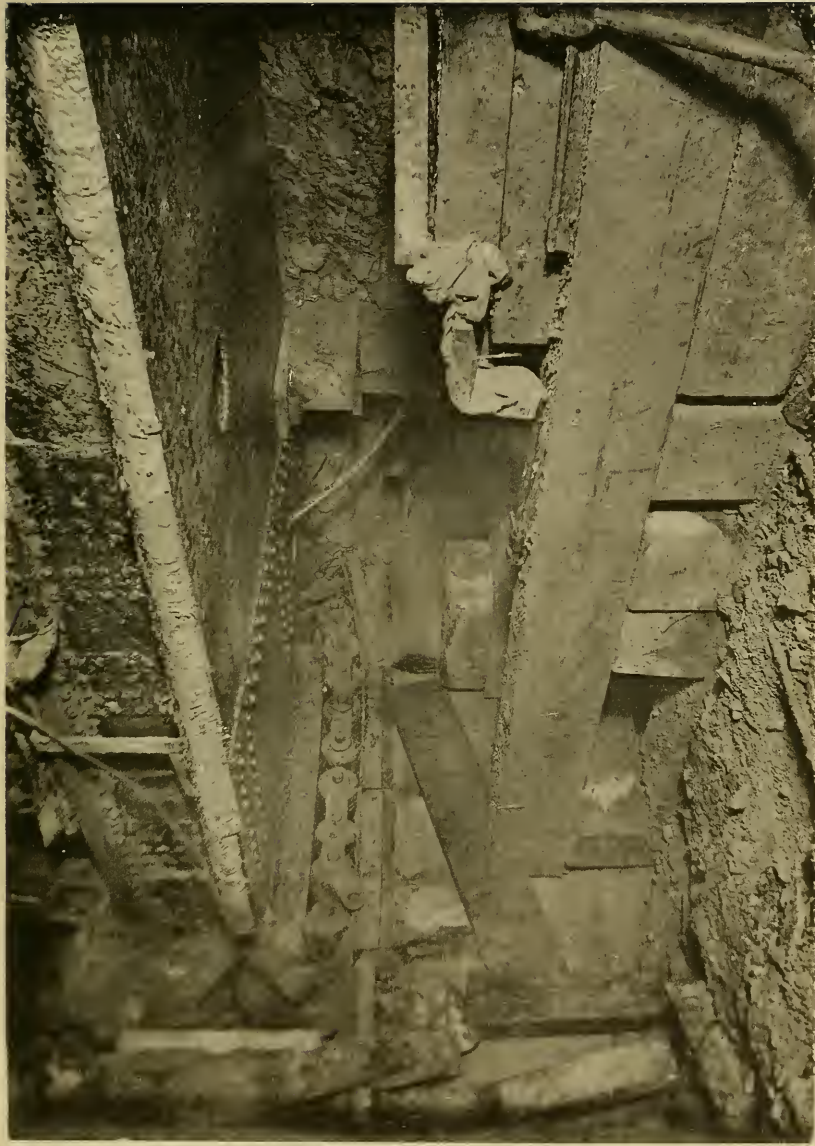
Halcyon Co. E. 1901.

SECTION B OF THE EAST BOSTON TUNNEL, PART OF WINDING MACHINERY AND CARS
SOUTHWEST OF AIR LOCKS. (LOOKING SOUTHWESTERLY.) OCT., 1901.



Holotype Co., Boston

SECTION B OF THE EAST BOSTON TUNNEL, ENTRANCE TO NORTHERLY PUMP
CHAMBER DURING EXCAVATION OF PIT. (LOOKING WESTERLY). MAY., 1902.



Helmyer Co. Boston

SECTION B OF THE EAST BOSTON TUNNEL, BOTTOM OF SHIELD AND BROKEN PLATE
WITH PREPARATIONS BEGUN FOR REPAIRS. (LOOKING SOUTHERLY.) JAN., 1902.

the space between the concrete and the sides of the excavation is filled with thoroughly rammed clay with the object of securing a barrier against the entrance of water.

The portion of the tunnel east of the pump well has a grade of about 5 per cent. The empty earth cars and those filled with concrete descend this slope by gravity with considerable velocity, and the returning cars are hauled up with ropes by means of winding engines. In the nearly level portion of the tunnel, west of the pump-well, mules are used to haul cars to and from the headings.

The progress of the excavation was somewhat delayed at a point about 600 feet southwest of the East Boston shore line where the clay was softer than usual and in consequence the drifts settled from 4 to 12 inches and the walls could not be brought up to their proper height. The track for the shield to run on was brought up to the usual height by means of a blocking of wood on top of this low wall. The wood crushed under the load of the shield and allowed it to settle at the forward end. This increased the stress upon the I-beams which formed the shoes, and they both broke about 15 inches from the front end of the shield. This break, illustrated by plate 5, was of such a serious nature as to make it necessary to jack up the shield and replace the I-beams with others reinforced with steel plates riveted on each side of the web.

The air pressure in the tunnel during the year has usually been about 22 pounds per square inch above the atmosphere. It has been increased to 25 pounds when unusually soft clay was met or strata containing sand, gravel, and water. Bubbles of escaping air can be detected over the tunnel in the harbor, and during wet weather they have been noticed on the surface of Lewis street.

The temperature in the upper part of the shield is about 80 degrees F., beneath the shield and in the drifts about 74 degrees, while near the locks on the compressed air side it is about 93 degrees.

During the last 10½ months the amount of carbonic acid gas present at the working faces has varied from 1.2 parts to 1,000 parts of air to 5.7, and the average has been about 2.9 parts. The amount of free air per hour per man, pumped into the tunnel, has ranged from about 650 cubic feet to about 1,500 cubic feet, and averaged about 1,100. Although the assistants have been particularly requested to ascertain and report any cases of compressed air disease, such cases have been very rarely heard of.

Plant. — The only important addition to the plant has

been that of a Rand high pressure compressor with a capacity of 250 cubic feet of free air per minute.

Progress.

Some particulars as to the amount of work done on the portion of the tunnel under the harbor are given in the following table :

	Excavation.	Concrete.	Linear feet.
Date of beginning, 1900	Aug. 13	Sept. 19	
Amount of work done during year ending Aug. 15, 1901	<i>Cubic yards.</i> 15,824	<i>Cubic yards.</i> 5,017	614
Amount of work done during the 10½ months ending June 30, 1902..	34,816	11,518	1,450
Total amount of work done.....	50,640	16,535	2,064
Maximum progress per week during 10½ months ending June 30, 1902..	1,120	390	45
Estimated total quantities.....	106,200	36,400	4,397

At the present time (June 30, 1902) 2,060 feet of the masonry structure of Section B is practically completed, Each sidewall is constructed for about 100 feet in advance and the headings of the side drifts are about 50 feet still further beyond.

The progress by weeks of arches turned for the period covered by this report is shown by the following table :

		Station of forward end of rib.	Progress during week, feet.
1901.			
Aug.	17.....	14 + 67.50	
"	24.....	15 + 02.50	35.00
"	31.....	15 + 32.50	30.00
Sept.	7.....	15 + 50.00	17.50
"	14.....	15 + 85.00	35.00
"	21.....	16 + 22.50	37.50
"	28.....	16 + 57.50	35.00
Oct.	5.....	16 + 90.00	32.50
"	12.....	17 + 22.50	32.50
"	19.....	17 + 55.00	32.50
"	26.....	17 + 87.50	32.50
Nov.	2.....	18 + 12.50	25.00
"	9.....	18 + 22.50	10.00
"	16.....	18 + 50.00	27.50
"	23.....	18 + 75.00	25.00
"	30.....	19 + 07.50	32.50
Dec.	7.....	19 + 37.50	30.00
"	14.....	19 + 65.00	27.50
"	21.....	19 + 97.50	32.50
"	28.....	20 + 20.00	22.50
1902.			
Jan.	4.....	20 + 55.00	35.00
"	11.....	20 + 85.00	30.00
"	18.....	21 + 00.00	15.00
"	25.....	21 + 00.00	0.00
Feb.	1.....	21 + 20.00	20.00
<i>Carried forward</i> .....		.....	652.50

		Station of forward end of rib.	Progress during week, feet.
<i>Brought forward</i>			652.50
1902.			
Feb.	8.....	21 + 55.00	35.00
"	15.....	21 + 95.00	40.00
"	22.....	22 + 35.00	40.00
March	1.....	22 + 72.50	37.50
"	8.....	23 + 07.50	35.00
"	15.....	23 + 42.50	35.00
"	22.....	23 + 77.50	35.00
"	29.....	24 + 10.00	32.50
April	5.....	24 + 45.00	35.00
"	12.....	24 + 80.00	35 00
"	19.....	25 + 20.00	40.00
"	26.....	25 + 60.00	40.00
May	3.....	26 + 00.00	40.00
"	10.....	26 + 40.00	40.00
"	17.....	26 + 82.50	42.50
"	24.....	27 + 27.50	45.00
"	31.....	27 + 72.50	45.00
June	7.....	28 + 00.00	27.50
"	14.....	28 + 42.50	42.50
"	21.....	28 + 67.50	25.00
"	28.....	29 + 07.50	40.00
Total between dates given above.....			1,440.00

Of the pump chambers previously referred to, the one on the north side has been substantially completed, and that on the south side begun.

The contractors' men have in general worked in two ten-hour shifts, from 7 A.M. to 6 P.M. for the day and from 7

P.M. to 6 A.M. for the night shift, each having one hour at noon or midnight for dinner. The day shift is ordinarily made up of about 120 men and the night shift of about 110. Some work requiring inspection has usually been done also in the intervals at morning, noon, and night. For this and other reasons the engineering assistants have generally worked in 8-hour shifts.

It is stated elsewhere that the walls which form the bottom, top, and sides of the tunnel are made of Portland cement concrete and that these walls are everywhere in contact with surrounding clay, usually in its natural bed, but in some cases substituted for sand and gravel found in pockets which the tunnel excavation has penetrated. The concrete is rich and dense, and appears when tested in small quantities to be thoroughly watertight. In such a mass as is found in the tunnel, however, shrinkage cracks occur at irregular intervals, and these may not always be calked tight, and imperfections caused by the carelessness of workmen may occur even under close inspection. Taking all these circumstances into account we may reasonably hope that the amount of leakage into the tunnel will not be excessive. The pump chambers which have been provided are probably considerably larger than will actually be required.

There has ordinarily been about 29 cubic feet of grout forced into place between the outside of each $2\frac{1}{2}$ foot length of arch and the surrounding earth. The proportions for this grout have been from 2 to 3 cubic feet of sand to 1 cubic foot of dry cement.

Many tests of a searching character have been and are being made with the object of securing Portland cement and concrete of the best quality. The interior of the tunnel will of course be in contact with the air. Such water as finds its way through the walls will probably, judging by that found during excavation, be almost wholly fresh. Tests of specimens of concrete nearly identical with that used in the tunnel walls are made to show how it endures respectively in air, in fresh and also in salt water. So far as these tests have gone they indicate that the cement is excellent and as good as can be found in the market and that the concrete is good and will be enduring. Some of the tests are to be found in Appendices T, U, V, W, and X.

Verification of Lines and Grades.

The line for the East Boston tunnel across the harbor from the foot of Lewis street in East Boston to the foot of

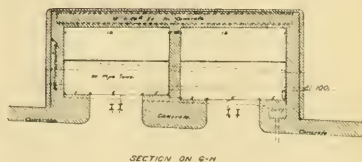
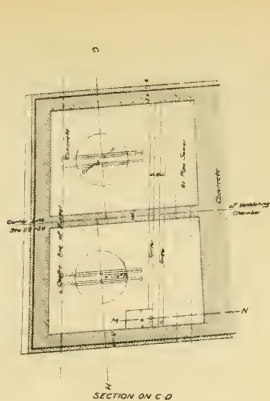
State street was measured by triangulation in the early part of 1901. The base line for this was made on the elevated railroad structure in Atlantic avenue from State street northerly to near Union wharf and was used before this part of the road was opened for traffic. From points on this base line angles were measured to a point over the line of the tunnel in East Boston. As a further check the line of the tunnel in State street was recently projected to a point near the end of Long Wharf, and from this point a base line was run in a northerly direction along the ends of the wharves about 1,200 feet. From the ends of this base line angles were taken to a point over the line of the tunnel near the foot of Lewis street, this point being fixed by projecting the line from the inside of the tunnel to the street from the shaft and the open incline at the entrance. The results of these two triangulations varied but little. The lines and grades in the tunnel are given by the engineering party on the work and have been checked several times by other assistants from the main office.

Atlantic Chambers — Open-Cut Portion of Section B.

It is proposed to place a passenger station at the foot of State street, westward of Atlantic avenue. This as designed will have two side platforms each 160 feet long, 10 feet wide, and 54 feet below the street level. This portion of the station will probably be covered by a masonry arched roof. To the east of each platform a space about 32 feet long and 18 feet wide is reserved for elevators, stairways, and approaches. These and the track space between them will be included in a larger space, 40 feet by 57 feet 4 inches, which will be nearly enclosed by four vertical walls extending to the surface of the street. These walls are from $1\frac{3}{4}$ to 3 feet in thickness reinforced by twisted steel bars. They are connected by three floors which altogether form four chambers, and are for convenience called the Atlantic avenue chambers.

Some account of pipe and sewer changes that were necessarily made prior to beginning excavation for the chambers is given in Appendix F.

Work on the excavation for these chambers began Dec. 5, 1901, and has been, together with the concrete masonry work, progressing very slowly since that time. The excavation has been by means of a portable derrick to a depth of 64 feet in small openings approximately 18 by 26 feet in plan. Wakefield sheeting was used to a depth of about 30 feet, and below that poling planks. For the first 20 feet in



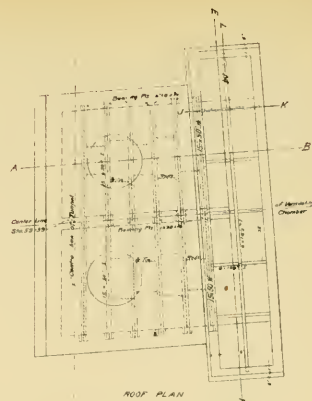
VENTILATING CHAMBER.



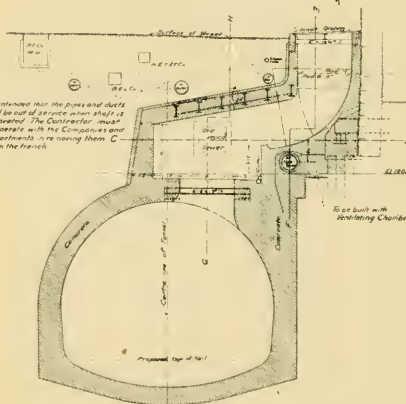
CONTRACT PLAN, SECTION C, EAST BOSTON TUNNEL.

Drawn by N. B. Little
Checked by N. B. Little
Reading by C. J. D.

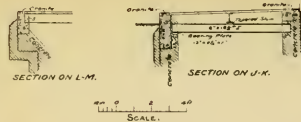
H. B. Carlson



NOTE: It is intended that the pipes and shafts shall be laid out as shown when they are excavated. The Contractor must cooperate with the Commissioners and Superintendents in removing them from the trench.



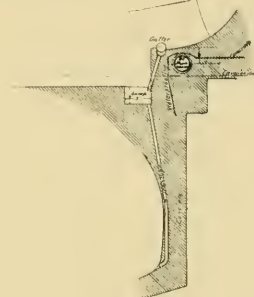
SECTION ON A-B.



SCALE.



SECTION ON E-F.



SECTION ON M-N.

0 2 4 6 8 10
SCALE

NOTE: The general character of the foundation and the position of any given point cannot be known and is subject to the Engineer's opinion. The Engineer is not bound by the contract to maintain the same. The position and character of any given point cannot be known and is subject to the Engineer's opinion. The Engineer is not bound by the contract to maintain the same. The position and character of any given point cannot be known and is subject to the Engineer's opinion. The Engineer is not bound by the contract to maintain the same.

depth the excavated material was filled ground composed of a mixture of sand, gravel, ashes, clay, logs, and boulders. Silt was encountered for the next 8 feet in depth, and below this blue clay to the required bottom. The progress of the work was retarded by the inflow of water, and it was at times found impracticable to work except during low tide. A pulsometer with a 4-inch discharge has been employed to remove the water from the trench. At the present time (June 30, 1902) only the wall on the south side of the chamber has been completed.

Progress on Atlantic Chambers.

	Excavation.	Concrete.
Date of beginning.....	Dec. 5, 1901.	Feb. 6, 1902.
Amount of work done during the 7 months (nearly) ending June 30, 1902	<i>Cubic yards.</i> 1,600	<i>Cubic yards.</i> 310
Maximum progress per week.....	164	63
Estimated total quantities	6,500	1,400

The work has been carried on mostly in the day time and by a single shift made up of about 30 men and 6 double teams.

SECTION C OF THE EAST BOSTON TUNNEL.

This section extends from about the middle of India street along State street about 750 feet to the Atlantic chambers 75 feet west of Atlantic avenue and includes the platform part of the passenger station which is to be made in that locality and which has already been referred to. The tunnel proper will be 23 feet 8 inches wide inside and 20 feet 8 inches in height. The invert will be 24 inches thick, the arch 31, and the sidewall from 31 to 33 inches; all are to be of concrete. The cross sectional shape is shown on plate 6, which also shows the ventilating chamber to be built opposite India street. On account of the depth of the tunnel and for other obvious reasons it was impracticable to do the work by cut and cover process and the most westerly practicable position for a tunnel shaft, taking into account the large amount of street traffic, was opposite India street. The shaft involved an excavation 34 feet wide, 40 feet long,

and 41 feet deep. Numerous changes of pipes and sewer were required before the shaft could be excavated. Some details of these are given in Appendix G. Additional preliminary work is described in the following paragraph:

Supporting State Street Ends of Buildings between Commercial Street and Chatham Row, to Prevent Injury to them in building the Tunnel.

Contractors for construction. — The John Cavanagh & Son Building Moving Company.

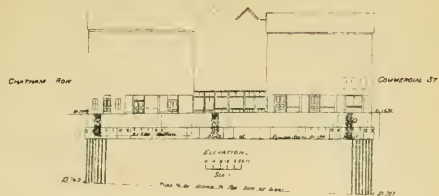
Date of beginning work.	Time of completion named in contract.	Date of final certificate.
Jan. 29, 1902.	March 22, 1902.	April 17, 1902.

The sides of the tunnel are in plan very close to these buildings, at the westerly end only 3 feet distant, and the bottom of the tunnel is 25 feet or more below the bottoms of their foundations. For these and other reasons it was thought prudent to give additional support to the ends nearest the tunnel. For this purpose the front foundation walls were pierced at intervals of about 4 feet and supported on steel I-beams. These beams were from 18 to 21 feet long and 18 inches to 24 inches high. Their front ends rest on a concrete wall under the sidewalk, the wall itself resting on piles reaching below the proposed bottom of the tunnel. The rear ends of the I-beams rest on a concrete wall that is nearly parallel to and about 18 feet from the front of the buildings. The rear wall was dug in the cellars and extended about 10 feet below the cellar bottom. Shorter I-beams support the party walls and are themselves supported by a portion of the long I-beams first referred to. All of these beams are below the cellars and surrounded by concrete which was carried up to the level of the cellar bottoms. A layer of asphalt waterproofing was imbedded at a depth of 12 inches from the cellar floor surface. The building walls were in each case carefully rebuilt where cut out for I-beams and the whole structures well secured. Plate 7 gives more detailed information in regard to the supporting of these buildings. Some delay in completing this work was caused by injunction proceedings of Walter Baker & Co.

Bids for Section C.

Bids were received February 25 for the construction of this section, but were deemed too high and were rejected.

The risk of settlement or other injury to buildings was of



a very uncertain or "gambling" character, and it may be that the bidders thought that this element justified their high bids.

The Commission decided to make some experimental contracts in which this risk would be assumed by the city, and if these contracts are carried far enough they will afford valuable information in regard to the risk and in regard to a fair price for construction under like conditions. The first of these contracts on Sections C and D were placed with Messrs. Gow and Foss and the work they have so far done appears to have been prudently and economically carried on. Mr. John E. Palmer is the resident engineer and has given much thought to the details of the work.

Plant Furnished by the Transit Commission.

The tunnel proper in Section C is only 600 feet long and required a shield, centering, and air locks that would have to be made expressly for it and other expensive plant that would not probably be available in the hands of any contractor who would bid on the work. If a contractor should purchase all of this plant it might be of little value to him after the contract was completed. The Commission might, however, find it necessary for completing Section B if any serious delay should occur in the progress of that work, and it might also be available in other ways. The Transit Commission could therefore better afford to purchase than a contractor, and it appeared probable that if the most expensive and unusual part of the plant was provided by the Commission, it would invite lower bids than would otherwise be obtained. The Commission accordingly did so provide. Some details regarding the plant are given in the following paragraphs.

Data in regard to Plant.

The roof shield was built by the James Russell Boiler Works Company, South Boston, who also built the shield for Section B and that for Section 6 of the Boston Subway. According to the terms of the contract the shield was to have been erected and completed April 15. It is not yet in, however, and from present appearances it seems probable that the contractor will be behind time a total of about 100 days. A part of this delay has been caused by the difficulty in getting material. The shield is substantially the same as that used on Section B except in the following particulars: The rear curved girder is greatly lessened in height at the crown (see plate 8) to facilitate keying up the concrete arch; the I-beams under the shield and over the sidewalls of the tunnel are 9 inches high instead of 6 inches; the rollers under the I-beams are 5 inches high instead of 8; the shield is 13 feet long instead of 12 feet 6 inches; the hydraulic jacks are of a different type and make.

Weight of shield without the hydraulic jacks and feed pumps, about 52 tons.

Diameter of shield, 28 feet 10 inches.

Sixteen hydraulic jacks (for pushing shield) made by The Watson-Stillman Company, of New York.

Three air-locks, each 6 feet in diameter and 30 feet long, built by E. Hodge & Company, of East Boston.

The India street power plant was furnished complete, except the building, set up and put in operation by the Ingersoll-Sergeant Drill Company. The principal items include the following:

Two straight line compressors, each of a nominal capacity of 800 cubic feet free air per minute compressed to 120 pounds pressure per square inch and having its air ends compounded.

Two straight line compressors, each of a nominal capacity of 1,000 cubic feet free air per minute compressed to 40 pounds pressure per square inch.

Two receivers into which the compressors deliver the compressed air, each 4 feet 1 inch diameter and 12 feet high.

One receiver to be used in the tunnel, 4 feet in diameter and 8 feet high.

Three horizontal return tubular boilers 6 feet in diameter with tubes 18 feet long placed in a brick setting, with gauge-cocks, water glasses, safety valves, tools to run and care for them, and all other appliances, fixtures, and mountings usually furnished. Boilers are to be run at 100 pounds pressure per square inch.

One smoke pipe five feet in diameter and 130 feet high.

The plant also includes a feed water heater, boiler feed pumps, water tank, smoke flue, and all gauges, tools, oil-cans, wrenches, etc., etc., necessary to operate the plant and keep it in good running order. The piping and valves are so arranged that any possible connection between the boilers and the high or low compressors can be made, and that any boiler or any compressor can be shut off without stopping the running of any one of the others, and so that the compressors can discharge into either receiver.

Twenty-five mud cars built of oak, with hinged sides. Capacity, 25 cubic feet; gauge, 18 inches; wheels, 10 inches diameter.

Four concrete cars—Steel box end-dump cars. Capacity, 22 cubic feet; gauge, 18 inches.

Fifteen tons rails. Sixteen-pound T-rails in lengths of 6 meters, or 19.65 feet, so they can be carried through the air-locks. These were ordered and delivered from Germany on account of the long time for delivery demanded by manufacturers in this country.

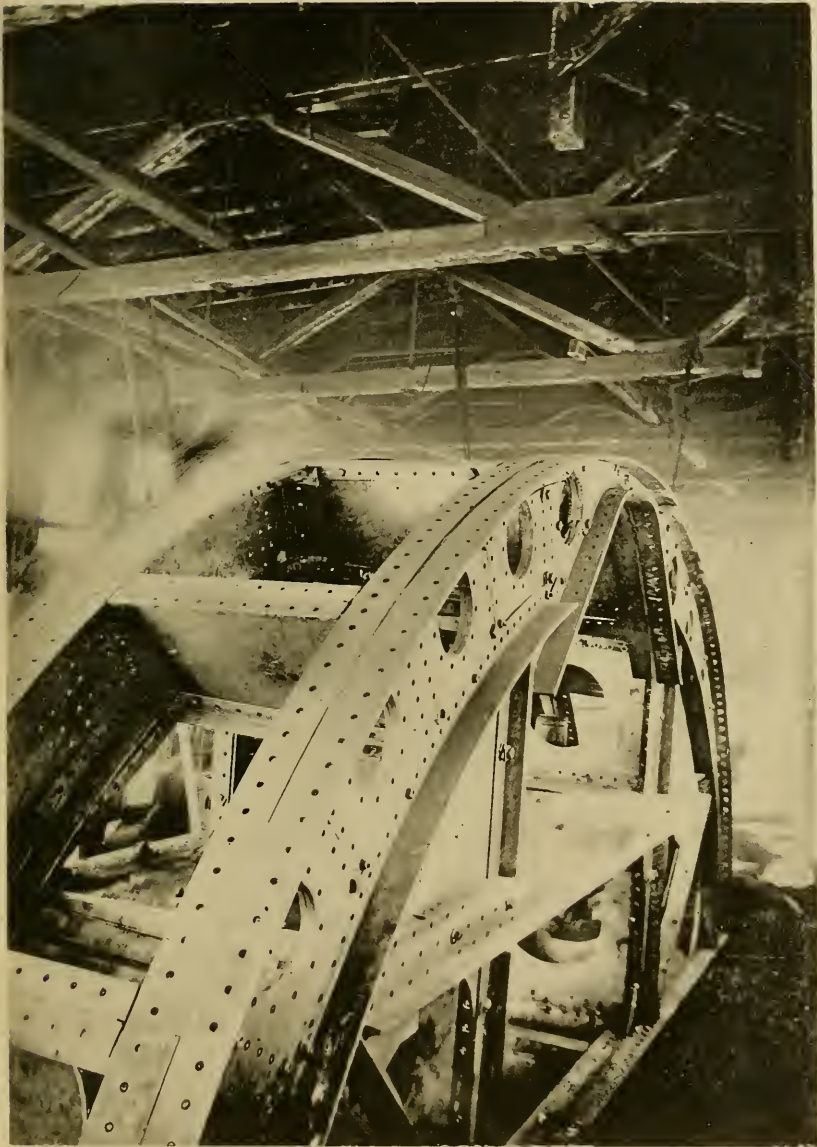
Thirteen switches. Seven right-hand and 6 left-hand switches built in one piece to an 18-inch gauge. Were delivered from Germany with the rails.

The foregoing cars, rails, and switches were furnished by Sherburne & Company, of Boston.

Elevator. One platform cage $5\frac{1}{2}$ by $6\frac{1}{2}$ feet rated to carry a load of 6,000 pounds equipped with counterweights and one set landing dogs. The elevator is operated by a hoisting engine with two cylinders 9 inches by 10 inches and a drum 33 inches in diameter. Elevator and engine furnished by National Contracting Company, of Boston.

Winding engine, double drum, to operate mud cars inside the air locks. Has two cylinders $7\frac{1}{2}$ inches by 10 inches and two drums each 24 inches in diameter set tandem. Reversible link motion. Will be operated by compressed air. Furnished by Lambert Hoisting Engine Company, of Newark, N.J.

Winding engine, single drum, to operate concrete cars inside the air-locks. Is a duplicate of the double drum engine except that it has but



H. H. H. H. H.

SECTION C OF THE EAST BOSTON TUNNEL, TOP AND REAR END OF ROOF SHIELD DURING CONSTRUCTION. MAY 23, 1902.

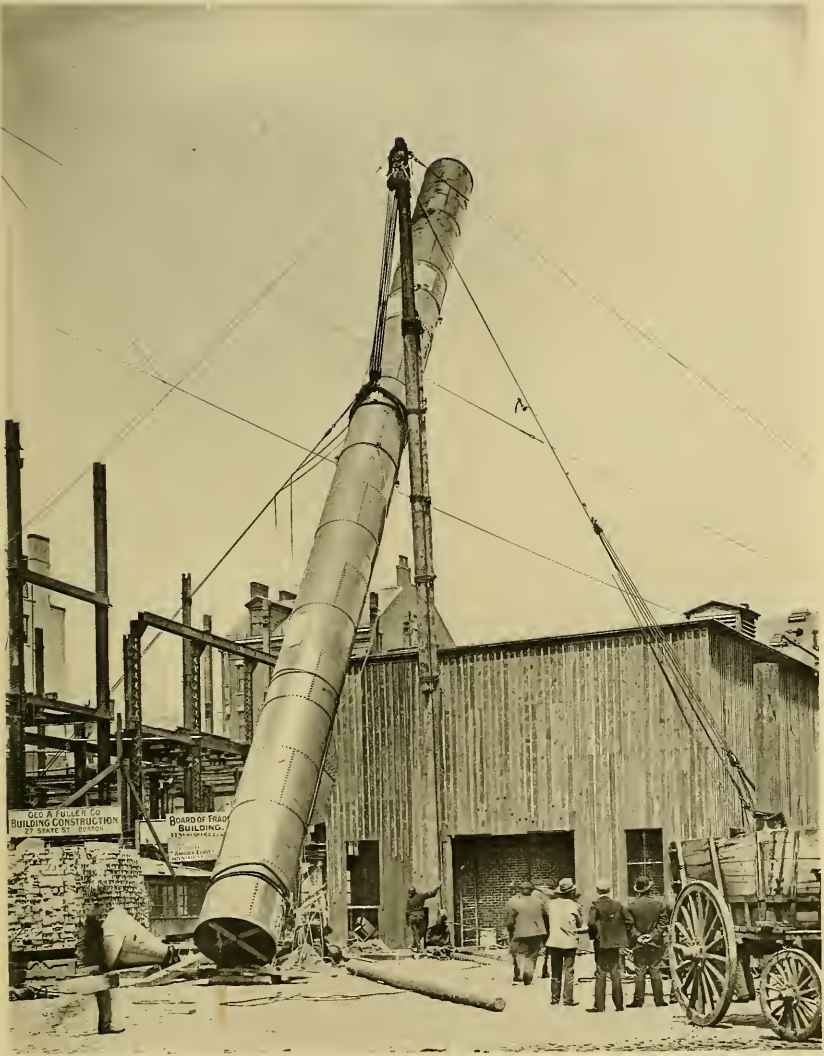


High angle view of tunnel

SECTION C OF THE EAST BOSTON TUNNEL, DETAIL OF SIDE OF ROOF
SHIELD. MAY 23, 1902.



SECTION C OF THE EAST BOSTON TUNNEL, PART OF ROOF SHIELD ABOUT TO BE LOWERED, NEAR THE CUSTOM HOUSE. (LOOKING SOUTHEASTERLY.)



H. A. H. B. B. B.

SECTION C OF THE EAST BOSTON TUNNEL, ERECTING SMOKE PIPE FOR AIR
COMPRESSING PLANT IN INDIA STREET NEAR STATE STREET.
(LOOKING NORTHWESTERLY.) MAY 22, 1902.

one drum. This engine is to be operated by compressed air. Furnished by Lambert Hoisting Engine Company, of Newark, N.J.

One concrete mixer. No. 3 Iroquois mixer. Capacity, 1 cubic yard per batch. Requires a 35-horse-power engine to operate. Mixer furnished by the Warren-Burnham Company, New York City.

Details of Construction. — A shaft (34 feet by 40 feet), as heretofore stated, was sunk in State street at the junction of India street to the required depth of 42 feet. The upper 20 feet of this shaft was through filled ground containing a grillage of logs. The latter is a portion of former wharf construction made at a time when the docks extended to the vicinity of Broad street. This material freely admitted a flow of water at every high tide. On this account a trench was excavated around the shaft and refilled with clay, resulting in a clay boxing 1 foot thick outside the lines of the shaft for a depth of 20 feet where it joined the geological stratum of clay. This boxing effectually stopped the flow of water. The excavated earth was hoisted from the shaft by means of a stiff-legged derrick and was taken away in carts, most of it going to Prison Point, Charlestown, and to other parts of the same dump in East Cambridge. When the shaft had been sunk the concrete invert was put in and the walls were constructed to within 12 inches of the springing line of the arch. After this was done excavation in side drifts 8 feet square, on each side of the tunnel, was begun, and they were extended 150 feet to the east of the shaft. They were timbered solidly with 8-inch by 8-inch spruce legs and caps. The legs were set on 4-inch by 12-inch blocks of hard pine. Concrete sidewalls on which the shield will run were built to the required elevation as fast as the drifts were excavated.

Most of the concrete was carried into the drifts and most of the excavated earth brought out by means of suspended buckets on double-wheel trucks running on overhead single tracks. Vulcanite cement has been generally used in the concrete, which is mixed in the proportion of 9 cubic feet of stone dust and 11 cubic feet broken stone to each barrel of cement.

Character of the Excavated Earth. — The first 20 feet in depth of shaft was, as already mentioned, of miscellaneous filled material and logs. The remainder of the shaft was through sandy clay. The drifts for the first 50 feet from the shaft passed through sandy clay and beyond that through blue clay.

Progress.

Date of beginning shaft	March 4, 1902.
Date when shaft was sunk to grade	April 19, 1902.
Cubic yards of excavation in shaft	2,010.
Date of beginning sidewall drifts	April 28, 1902.
Cubic yards of excavation in sidewall drifts to June 16, 1902, no excavation since that date	820.
Estimated total cubic yards of excavation aside from that in shaft	19,530.
Date of beginning concrete masonry	April 22, 1902.
Cubic yards of concrete masonry in place to June 19, 1902, none since that date	400.
Estimated total cubic yards of masonry,	6,500.

The excavation was stopped at the date mentioned because it was not thought prudent to proceed farther without the use of compressed air. The work has been since that time nearly at a standstill awaiting the arrival and setting up of the shield.

SECTION D OF THE EAST BOSTON TUNNEL.

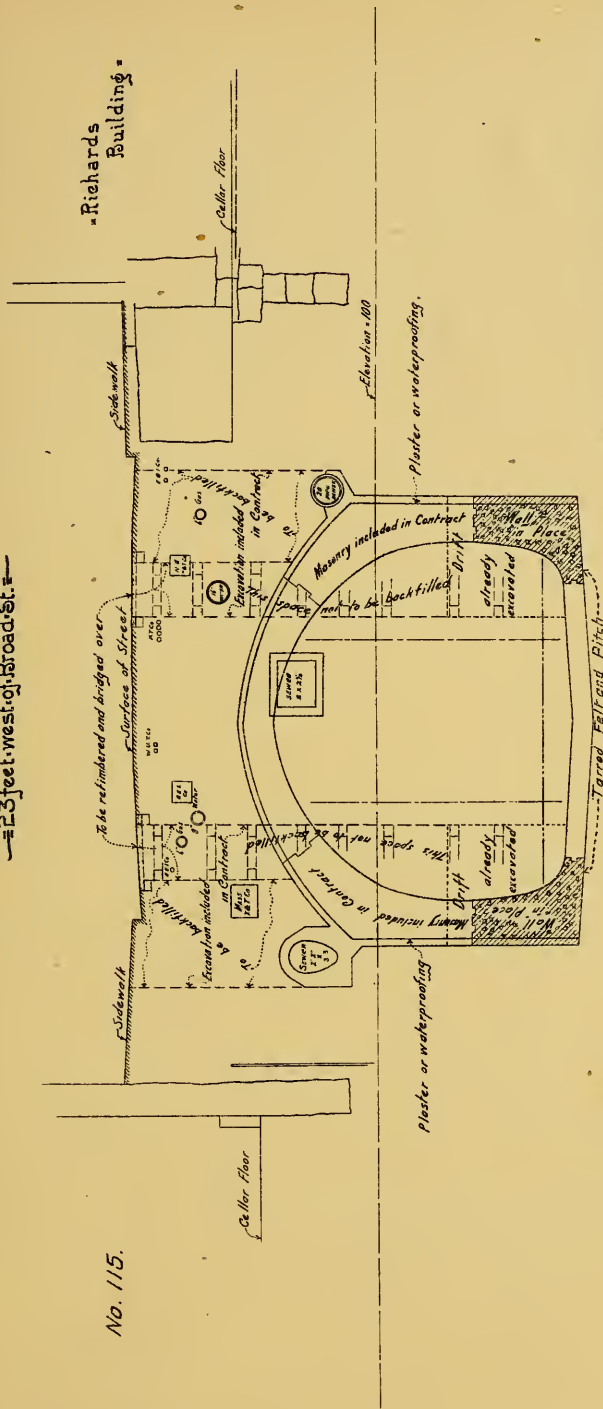
For convenience of reference the portion of the tunnel between the India street shaft and a point near the westerly end of the Exchange Building and of the Hospital Life Building is given the above name. The westerly end of Section D will be the easterly end of the proposed passenger station with exit under the Old State House. The above-named shaft was a convenient place for starting tunnelling drifts in which to make sidewalls for the easterly end of Section D, and drifts and walls were accordingly made to about the westerly side of Broad street. In addition to the drifts two test pits, so called, have to date (June 30) been wholly or partially excavated. Each test pit is from 16 to 32 feet long and wide enough to put in a portion of the sidewall of the tunnel and a small sewer. The earth so far excavated is sand and gravel containing some water. Plate 12 shows cross-sections of sidewalls and sewer at one locality. These test pits and others that will soon be made will indicate the character of the earth to be excavated and will show the effect on the neighboring buildings of excavation carried below their foundations. The first test pits are made near buildings that are to be torn down. As above indicated there is to be a length of sidewall and of sewer in each pit.

CROSS SECTION: STATION 61+90

=23 feet west of Broad St.=

No. 115.

Richards Building



NOTE:—The precise character of the foundation and the section at any given point cannot be determined in advance, but will be decided upon by the Engineer as occasion demands. The work is to be done in such a manner that the tunnel shall be ready to receive the water at the present depth, space shall be kept open for ventilation.

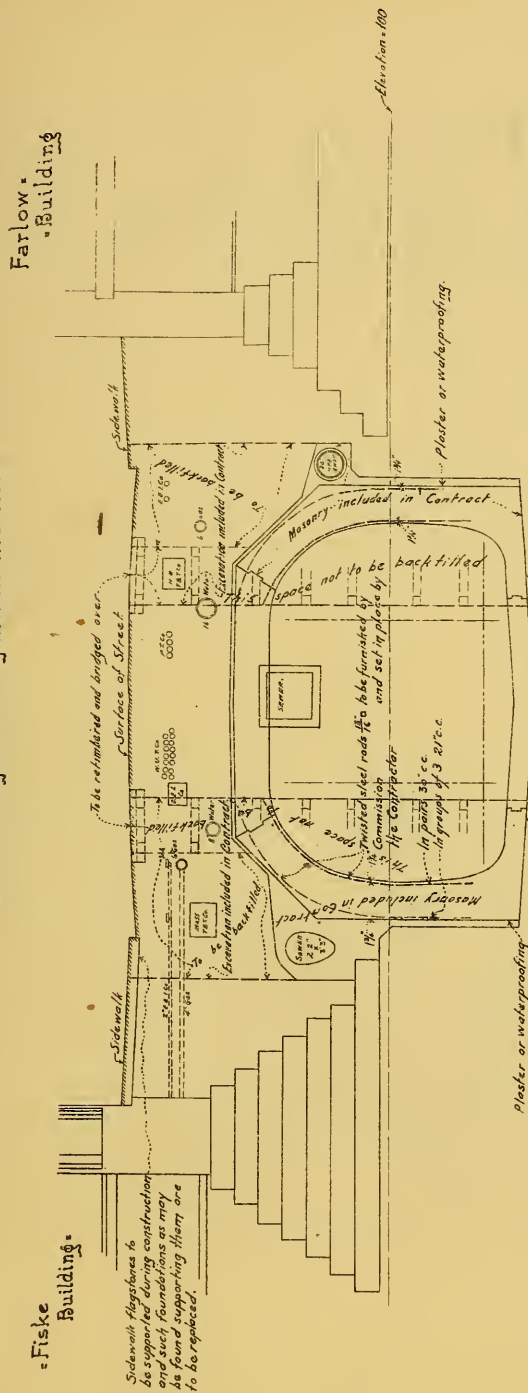
The cut of all foundation piling and form should be covered by the price, and for each excavation and concrete.

CONTRACT PLAN. SECTION D, EAST BOSTON TUNNEL.

Drawn by O.H.H. in S.R. 1892.
Traced by J.B. & G.B.
Printed by O.H.H.

Wm. Cullen Civil Engineer.

CROSS SECTION : STATION 63+10
 —About 25 feet east of Merchants Row—



NOTE—The space between the foundation and the ceiling of any open shaft cannot be determined in advance, but will be decided upon by the Engineer, at occasion demands.
 Dimensions are referred to a datum about 100 ft. below mean low water of sea.
 The bridge and underground of pipes and other underground objects shown are supposed to be approximately correct, but should they be found to be otherwise, the Contractor shall have no claim on this account, it being expressly understood that the Commission do not warrant the plan to be correct.
 Samples of material from the borings can be seen at the office of the Commission.
 The mass over the excavation shall be covered by a substantial bridge set flush with the pavement. Adequate space shall be kept open for ventilation.

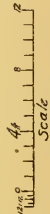
The cut and all the
 building retaining and forms should be covered by the process for the earth excavation and concrete.

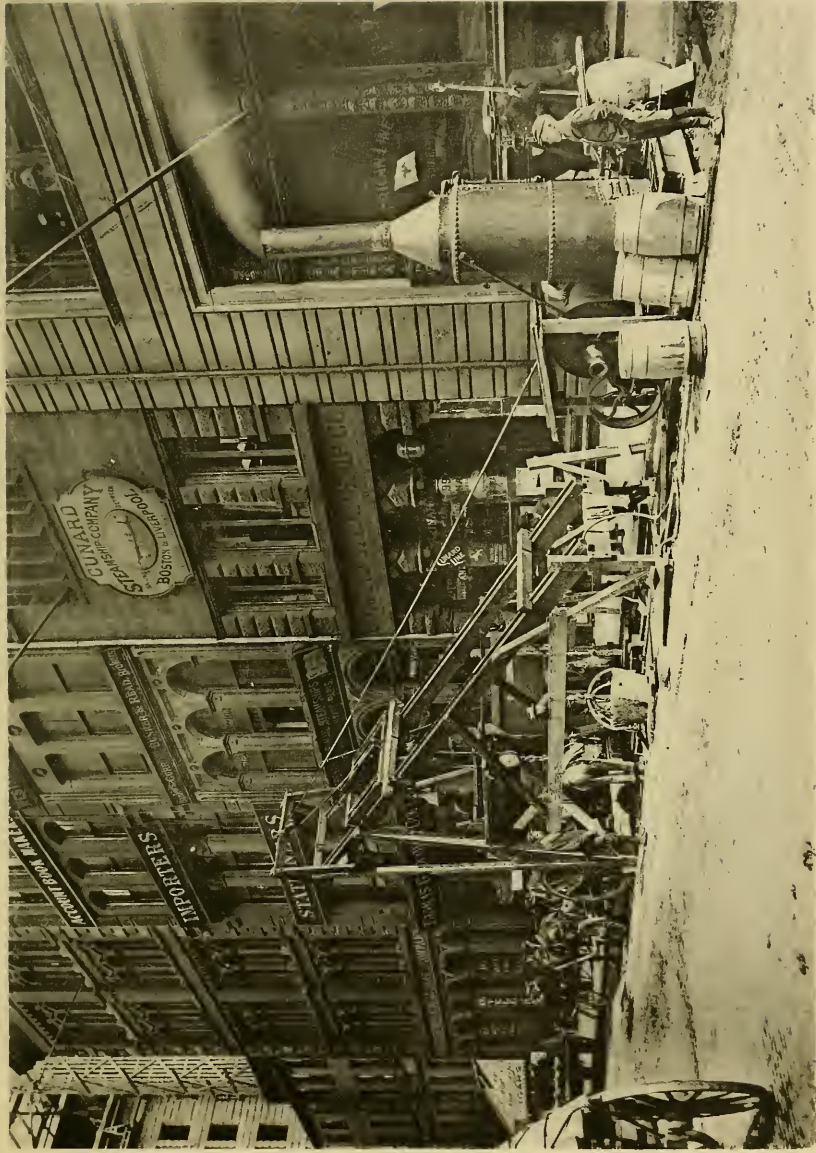


CONTRACT PLAN, SECTION D, EAST BOSTON TUNNEL.

Drawn by *W.H.C.* 11-13-1916.
 Traced by *G.G.B.* 8-24-16
 Revised by *W.H.C.*

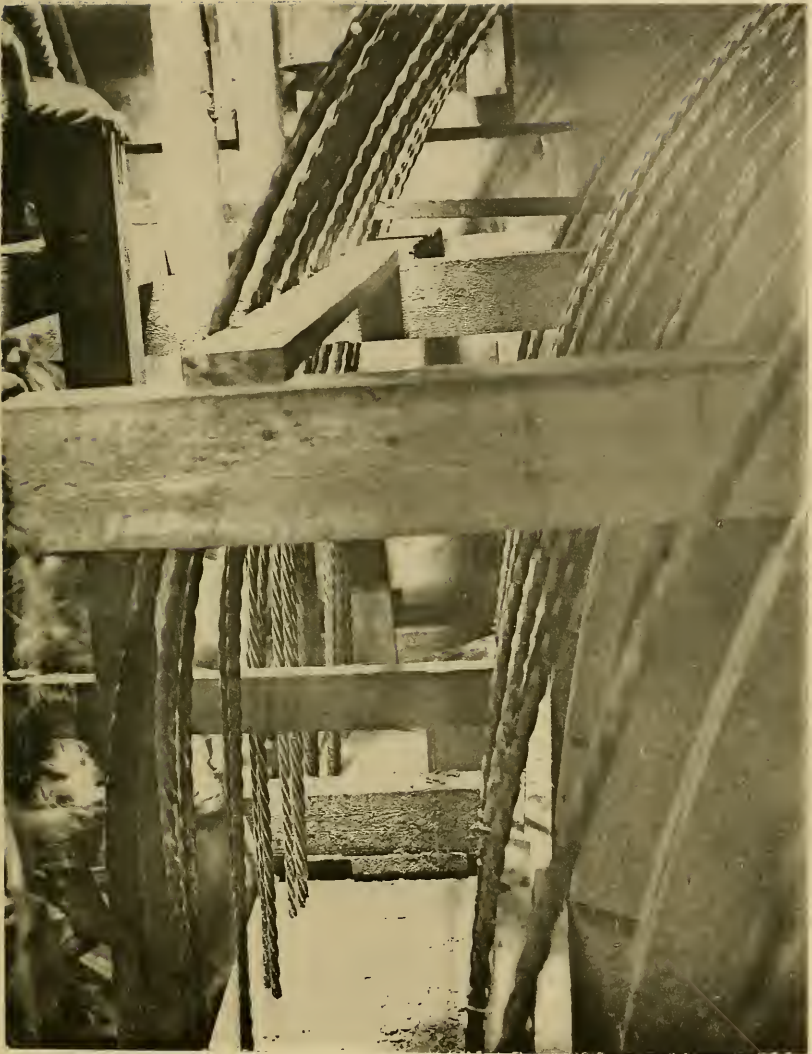
H. H. Barker Chief Engineer.





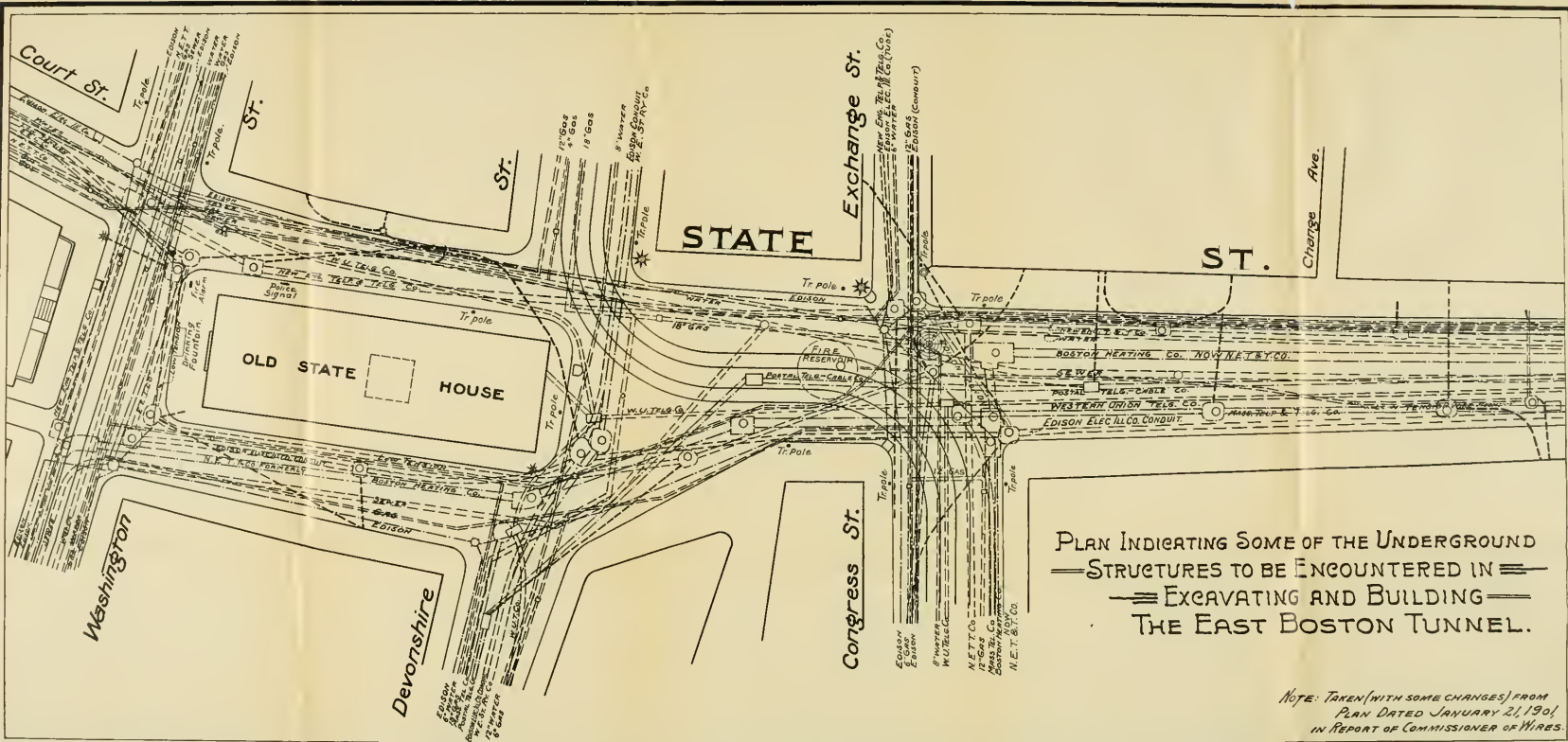
Holmtype Co. Boston.

SECTION D OF THE EAST BOSTON TUNNEL, EXCAVATING FOR TEST PIT
IN FRONT OF THE FISKE BUILDING. (LOOKING EASTERLY.)



Heliotype Co. Boston.

SECTION D OF THE EAST BOSTON TUNNEL, IN FRONT OF THE EXCHANGE BUILDING, TWISTED STEEL RODS WHICH ARE IMBEDDED IN THE MASONRY OF THE SIDEWALLS. (LOOKING WESTERLY.)



NOTE: TAKEN (WITH SOME CHANGES) FROM
PLAN DATED JANUARY 21, 1901
IN REPORT OF COMMISSIONER OF WIRKS.

Advertisement will soon be made for all of the remaining side walls and sewers in Section D and the bidders will be invited to examine the test pits previously made.

When the sewers on each side of the street have been completed and house connections made thereto, the old sewer near the middle of the street which is in the way of the arch of the tunnel can be abandoned; and when the side-walls are well under way the slow and tedious work can begin of relaying in a more orderly manner such of the tangled network of pipes and ducts as interfere with the tunnel construction. Plate 16 may give an idea of some of the underground objects to be found in this vicinity.

COMPLETION OF VENTILATING CHAMBER IN HANOVER STREET NEAR WASHINGTON STREET. (CONTRACT WORK.)

The ventilating chamber at the junction of Washington and Hanover streets is included in Section 10 of the subway. This section was completed more than five years ago, but the ventilating chamber was left unfinished as it was decided at that time not to complete it until the East Boston tunnel was built, it being then thought that the route for this tunnel would be through Hanover street. The line ultimately decided upon for the East Boston tunnel, however, was through State street, so that the reason for waiting no longer existed. The work of completing the chamber was accordingly begun November 5, and was finished December 21, 1901.

Respectfully submitted,

H. A. CARSON,
Chief Engineer.

APPENDIX A.

DECISION OF THE SUPREME COURT IN THE CASE OF
GEORGE G. CROCKER AND OTHERS *v.* BOSTON ELECTRIC
LIGHT COMPANY.

[180 Mass. 516.]

SUFFOLK.

January 9, 1902. — February 27, 1902.

Present: HOLMES, C.J., LATHROP, BARKER, HAMMOND, & LORING, JJ.

Practice, Civil. Agreed facts. *Contract, Implied.* *Boston Transit Commission, Powers.* *Jurisdiction.* *Way.*

No question of pleading is open when a case is reserved on agreed facts, unless it is specially reserved.

Under St. 1894, c. 548, § 36, it was the duty of the Boston Electric Light Company to incur the expense of removing a certain conduit containing its wires, found by the transit commission to interfere with the construction of the subway, and of building it in a new location granted for it by the commission, if it wished to have it rebuilt. That company refused to remove the conduit unless the commission would pay the cost of removal. The commission, after notice that they should do so at the expense of the light company, removed the conduit and constructed it in the new location paying the expense. Thereupon the light company used and continued to use the conduit in its new location. In an action by the commissioners against the light company to recover the expense thus incurred, it was *held*, that the defendant at this stage and after having used the conduit could not raise the point that it did not wish to have it rebuilt, and that the commissioners, having been forced to incur the expense by the failure of the defendant to perform its statutory duty, could recover the amount on an implied contract. *Also*, that the commission had the power to relocate the conduit.

The jurisdiction given to this and the Superior Court by § 20 of St. 1894, c. 548, providing for rapid transit in Boston, to compel compliance with the provisions of that act, is not exclusive of other remedies.

The provisions of Pub. Sts. c. 49, § 17, as to the removal of buildings or materials from land taken for a highway, have no application to a removal of a conduit in the construction of the subway in Boston under St. 1894, c. 548, § 20.

CONTRACT, originally brought by the city of Boston, and later amended by substituting as plaintiffs George G. Crocker and others, constituting the Boston transit commission, appointed under St. 1894, c. 548, § 23, suing for the benefit of the city of Boston, for \$1,200.64, paid by the plaintiffs for removing and relocating a conduit pipe of the defendant, deemed by the transit commission to interfere with the construction of the subway, after the refusal of the defendant to remove it as required by § 36 of the same statute. Writ dated August 24, 1899, and amended by the substitution of the present plaintiffs, October 24, 1899.

Superior Court on agreed facts gave judgment for the defendant; and the plaintiffs appealed.

T. M. Babson & C. B. Gleason, (A. C. Travis with them,) for the plaintiffs.

C. A. Snow, for the defendant.

LORING, J. This is an action by the transit commissioners of the city of Boston to recover the expense incurred by them in removing and re-locating certain conduits for the wires of the defendant on the corner of Boylston and Tremont Streets in the city of Boston. The first count is for the expense of removing the old conduits and the second is for that of reconstructing the conduits in the new location.

By § 36 of St. 1894, c. 548, the Boston transit commission were authorized to order "the removal or relocation of any conduits" which "it deems to interfere with the construction or operation of" the subway which they were authorized to construct; § 36 further provides that "the person or corporation owning such tracks, wires or other property shall comply with said orders."

The plaintiffs deemed that the conduits of the defendant at the corner of Tremont and Boylston Streets interfered with the construction of the subway, and, on January 2, 1897, passed a vote by which the defendant was "ordered to remove from its present location" its conduit at that point; the vote also provided that "a new location for said conduit is granted" as shown on a plan there specified, and that "the work of removal shall be begun as soon as the work of the subway will admit of it, and shall be completed as soon thereafter as is practicable." On January 23, 1897, the defendant wrote the plaintiffs acknowledging the receipt of the "vote of the Commission that this Company be ordered to remove its conduit from its present location at the junction of Tremont and Boylston Streets, and to place the same in a new location granted for that purpose, as shown on Plan 2670 of the Boston Transit Commission, dated December 30, 1896. In reply we have to say that this Company must decline to comply with said order of your Commission, unless you will agree to pay the actual cost of the work and material necessary for such compliance." The plaintiffs replied under the same date that "If your Company fails to comply with the order transmitted to you, January 2, 1897, the Boston Transit Commission will proceed to have the work done at the expense of your Company."

The plaintiffs, "after waiting a reasonable time," removed the old conduit and built a new conduit in the location specified. The work of removing the old conduit being covered by a general contract, the plaintiffs seek to recover the expense of constructing the new one only. It is agreed that the old conduit did in fact interfere with the subway, and it was stated at the argument that the defendant is now using the new conduit.

1. The defendant's first contention is that the allegations of the second count are not supported by the agreed facts. But no question of pleading is open where a case is submitted on agreed facts unless it is specially reserved. In this case, "all questions arising upon the defendant's demurrer" were reserved; but no question of variance was reserved; on the contrary, it is stated that "if the plaintiffs are entitled upon the facts above to recover from the defendant the expense of building a new conduit in the new location, judgment shall be entered for the plaintiffs in the sum of \$1,271.90."

2. The defendant's next contention is that it is not liable because it did not request the plaintiffs to remove the old conduit or to build a new one. By the true construction of St. 1894, c. 548, § 36, it was made the duty of the defendant to incur the expense of removing the old conduit on the plaintiffs' finding that it interfered with the subway, and of building it in the new location granted it, if it wished to have it rebuilt. The plaintiffs, in their vote of January 2, directed the removal of the old conduit and granted a new location for the conduit which was to be removed. The defendant, in acknowledging receipt of the vote, assumed, what was not covered by the vote, that the conduit was to be rebuilt and that the order directed that it should be rebuilt. The objection raised by it was that the cost of the removal and reconstruction in the

new location should be borne by the plaintiffs, and refused "to comply with said order" "unless you will agree to pay the actual cost of the work and material necessary for such compliance."

Had the defendant intended to raise the point that it did not wish to have the conduit rebuilt, it should have said so then, or at least taken the position that the plaintiffs must act in the matter at their peril. In place of doing so, they stated that they have received the order "to remove its conduit from its present location at the junction of Tremont and Boylston Streets, and to place the same in a new location granted for that purpose;" and the only objection then made to complying with the order was that the plaintiffs must agree to bear the expense. That disposes of the defendant's present contention that they did not then wish the conduit rebuilt. Had that not been enough to exclude that contention, the defendant's use of the conduit after it was built by the plaintiffs disposes of it.

On the broader question of the necessity of a request to make the defendant liable at all, we also agree with the plaintiffs. The statute made it the duty of the defendant to remove its conduit; on its failing to perform that duty, it was proper, for the plaintiffs to perform it at the defendant's expense, and having been forced to incur this expense which should have been met by the defendant, they are entitled to recover the amount thereof from it on an implied promise.

3. The defendant's next contention is that the plaintiffs had no power to grant the new location granted by it, but were by § 36 limited to designating "locations in or adjoining said subways and tunnels for sewers, gas pipes, water pipes, conduits and electric wires." We are of opinion that that clause of § 36 is in addition to the clause under which the commission acted in this case. That clause contemplated the adoption of a general scheme for pipes and wires adjoining the subway, without regard to their being new pipes and wires or old ones relocated. In addition to that power the commission had power to "relocate" any conduits which interfered with the construction of the subway, and in this case they acted under the latter power.

4. Again the defendant contends that the provisions of St. 1894, c. 548, § 20, giving this court and the Superior Court jurisdiction in equity to compel compliance with the act, excludes any other remedy. We are of opinion that that remedy is not exclusive.

5. There is nothing in the point that because the subway is a public way, Pub. Sts. c. 49, § 17, as to the removal of buildings or materials within the limits of the lay out of highways, applies to this case.

6. No question of the constitutionality of the St. 1894, c. 548, arises in this case. It is admitted by the plaintiffs that, if the defendant had a right to have its conduit in the public street, it is entitled to compensation for the expense of removing and rebuilding the conduit under St. 1894, c. 548, § 34, as amended by St. 1895, c. 440, § 1.

Judgment for the plaintiffs in the sum of \$1,271.90.

APPENDIX B.

AN ACT RELATIVE TO THE CONNECTING OF THE EAST
BOSTON TUNNEL, THE CAMBRIDGE STREET SUBWAY,
AND OTHER SUBWAYS.

[Stat. 1902, Chap. 114.]

Be it enacted, etc., as follows :

SECTION 1. The provisions of chapter five hundred of the acts of the year eighteen hundred and ninety-seven, relative to the construction of a tunnel to East Boston and a subway under Cambridge street, are extended so that the East Boston tunnel and the Cambridge street subway may, with the consent of the Boston Elevated Railway Company, be connected with the existing subway and with each other, and with any other subway, on such terms, in such manner and at such points, whether at grade or otherwise, as the Boston transit commission may deem that the public interests require.

SECT. 2. The provisions of chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four, of chapter five hundred of the acts of the year eighteen hundred and ninety-seven, and of the acts in amendment of or in addition to said acts, shall apply to the Boston transit commission and the members thereof in the execution of any work authorized by law to be done by said commission.

SECT. 3. This act shall take effect upon its passage. [*Approved February 25, 1902.*]

APPENDIX C.

AN ACT TO PROVIDE FOR THE CONSTRUCTION OF ADDITIONAL TUNNELS AND SUBWAYS IN THE CITY OF BOSTON.

[Stat. 1902, Chap. 534.]

Be it enacted, etc., as follows:

SECTION 1. The Boston transit commission, hereinafter called the commission, may construct in the city of Boston, hereinafter called the city, a system of tunnels and subways so designed as to be adapted for the accommodation of two tracks especially for use by elevated cars or trains and two tracks especially for use by surface cars, from a point or points near the junction of Broadway and Washington street or within one thousand feet therefrom, through and under public streets, squares or places and public or private lands, between the existing subway and a line parallel with and seven hundred and fifty feet easterly from Washington street to the line of Court and State streets, and thence northerly by such route as may be deemed best, to a point or points in or near Adams square, Haymarket square or Causeway street, together with approaches, sidings, entrances, stations, elevators, inclines, connections and other structures, hereinafter called appurtenances, which shall also include connections either at grade or otherwise with the East Boston tunnel and the existing subway.

The structure for the two tracks especially adapted for elevated cars or trains, hereinafter called the tunnel, shall be begun immediately after the acceptance of this act by a majority of the voters of the city as hereinafter provided. The structure for the remaining two tracks, hereinafter called the subway, shall be begun at such time after the expiration of one year from the completion of the tunnel as the commission and the Boston Elevated Railway Company, hereinafter called the company, may agree upon, or, in case of difference, as the board of railroad commissioners, hereinafter called the board, shall determine that the public interests require. The structure or structures for all four tracks, with the appurtenances, or any part or parts thereof, may be begun at any time after the acceptance of this act by a majority of the voters of the city as hereinafter provided, if and so far as the commission deems it expedient and if the company by its board of directors consents thereto.

SECT. 2. The commission shall immediately after the passage of this act make such preliminary investigations, surveys and plans as it deems expedient, and to that end may enter upon any lands and place and maintain marks therein, and may make excavations, borings and do all other acts necessary for such investigations and surveys. The commission may expend such sums as it deems necessary therefor. The expenses incurred in making such preliminary investigations, surveys and plans shall be paid from the loan authorized by chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four and acts in addition thereto, but if construction is begun hereunder the amount so expended shall be transferred and charged to the cost of such construction.

SECT. 3. The commission shall not begin the work of construction

until it has filed in the office of the city engineer a plan signed by the commission showing the location of that part of the work which it is about to construct. Any such plan so filed may be altered at any time by a new plan signed and filed in like manner.

SECT. 4. The commission may make contracts in the name of the city for the work herein authorized, but all contracts involving two thousand dollars or more in amount shall be in writing and signed by a majority of the commission; and no such contract shall be altered except by an instrument in writing signed by the contractor and a majority of the commission, and also by the sureties, if any, on the bond given by the contractor, for the completion of the original contract. No such contract or alteration of any such contract shall be valid or binding on the city unless executed in the manner aforesaid.

SECT. 5. All work done under this act under or near public streets and places shall be conducted, so far as practicable, in such manner as to leave such streets and places, or a reasonable part thereof, open for traffic between the hours of eight in the forenoon and six in the afternoon of each secular day except public holidays.

SECT. 6. The commission may for the purposes of this act use public ways and lands without compensation therefor, and may take for the city, by purchase or otherwise, lands in fee and easements, estates, and rights in land, including the right to go under the surface thereof or through or under buildings or parts of buildings thereon, and such takings in fee or otherwise may be made whether the lands taken or otherwise affected are held under or by title derived under eminent domain or otherwise. A taking under this section of an easement or other estate or right in a given parcel of real estate, whether such parcel consists of unimproved land or of land and buildings, may be confined to a portion or section of such parcel fixed by horizontal planes of division below or above or at the surface of the soil, and in such case no taking need be made of upper or lower portions or sections, except of such easements therein, if any, as the commission may deem necessary. The commission, to make any taking by right of eminent domain, shall cause to be recorded in the registry of deeds for the county of Suffolk a description of the lands, easements, estates or rights to be taken, as certain as is required in a common conveyance of land, with the statement that the same are taken under authority of this act, which description and statement shall be signed by the commission; and the lands, easements, estates or rights therein described shall upon such recording be taken for and shall vest in the city. The commission shall, so far as may be practicable, notify all known owners of such takings, but the validity thereof shall not be affected by want of such notice.

SECT. 7. The commission may sell or remove the buildings from any and all lands taken by it, and shall sell, if a sale be practicable, or if not shall lease, any lands, or rights or interests in land or other property so taken, or purchased for the purposes of this act, whenever the same shall in the opinion of the commission cease to be needed for such purposes. The proceeds of such sales, and the fair valuation of any such lands or other property no longer needed for such purposes but not actually sold, as agreed on by the commission and the company, or in case of difference as determined by the board, shall be deducted from the cost of the tunnel or the subway, as the case may be, for the purpose of ascertaining the rental thereof.

SECT. 8. The commission shall determine and award the damages sustained by any person by reason of property taken or injured by the commission under authority of this act, except public ways or lands, and may agree with any person as to the amount to be paid as damages sustained by him for any property so taken or injured, which damages the city shall be liable to pay. If such person is dissatisfied with such award, or cannot agree with the commission upon his damages, the

same may be determined by a jury in the superior court for the county of Suffolk, on petition therefor of such person or of the commission against the city, filed in the clerk's office within one year after such property is so taken or injured; and judgment shall be entered upon the determination of such jury and costs shall be taxed and execution issued in favor of the prevailing party as in civil cases. The members of the commission shall not be personally liable for any such damage.

SECT. 9. The commission may order the temporary removal or relocation of any surface tracks, and the temporary or permanent removal or relocation of any conduits, pipes, wires, poles or other property of any person or corporation, which it deems to interfere with the construction or operation of the tunnel or subway, and shall grant new locations for any such structures so removed or relocated. Such orders, to the extent specified therein, shall be deemed a revocation of the right or license to maintain such tracks, conduits, pipes, wires, poles or other property, and the owner of any such structures in public ways or lands shall comply with such orders without expense to the city. If such owner shall fail to comply with the order of the commission within a reasonable time, to be fixed in the order, the commission may discontinue and remove such tracks, conduits, pipes, wires, poles or other property, and may relocate the same, and the cost of such discontinuance, removal or relocation shall be repaid to the city by the owner. No such discontinuance, removal or relocation shall entitle the owner of the property thus affected to any damages on account thereof. Any such structures in or upon private lands may be removed and relocated by the commission, or if removed and relocated by the owner thereof the reasonable expense shall be repaid him by the commission. Any gas company may shut off the gas from any pipes affected by any acts done hereunder, when and so far as it may be necessary to avoid danger of escape or explosion of gas.

SECT. 10. The commission shall within ninety days after the passage of this act execute with the company, in the name of the city, the company consenting thereto, a contract in writing for the sole and exclusive use of the tunnel and subway and appurtenances for the period of twenty-five years from the beginning of the use of the tunnel, at an annual rental equal to four and one-half per cent of the net cost of the tunnel and subway, respectively, for the running of trains and cars therein, and for such other uses and upon such provisions and conditions, not affecting the term or rental, as the commission and the company may agree upon, or in case of difference, as the board may determine. The provisions of this act, in so far as they declare, define or establish the terms and conditions for the construction, tenure, maintenance and operation of said tunnel, subway and appurtenances, shall be embodied in and made part of said contract. The use of the tunnel or subway respectively shall begin when, in the opinion of the commission, a reasonable time after completion has been allowed for equipment. The net cost of the tunnel and subway respectively shall be deemed to include all expenditures incurred in acquisition and construction, including damages, expenses and salaries of the commission, and interest at three and one-fourth per cent per annum on the debt incurred in construction prior to the beginning of the use. If the contract for the use of the tunnel and subway is executed as above provided the commission, upon the acceptance of this act by the voters of the city as hereinafter provided, shall proceed with the work of construction.

SECT 11. If the company shall execute the contract hereinbefore provided for, the company may, before the completion of the tunnel, construct lines or elevated railway according to such plans as the board may approve, to be operated by electricity or by such other motive power except steam, as may be approved by the board in respect of

the locations heretofore granted to the company, upon the following locations, which are hereby granted therefor, and may equip, maintain and operate engines, motors, trains and cars thereon, to wit: — (a) beginning at the southerly end or ends of the tunnel, thence upon and over any streets and public or private lands to the company's elevated structure now erected on or near Washington, Mott or Castle street; (b) beginning at the northerly end or ends of the tunnel, thence upon and over any streets, squares and public or private lands to the company's elevated structure now erected on or near Causeway street; and (c), such other locations as may in the opinion of the board be necessary or convenient to connect the tunnel with the elevated structures of the company. For the purposes of this act, including all equipment or other expenditure by the company thereby required or authorized, the company may issue such amounts of its stock or bonds, or of each, as may be necessary therefor, subject to all laws applicable to such issue; and it shall have all the rights and powers, and be subject to all the restrictions, liabilities and obligations conferred or imposed by sections eight, nine, eleven, twelve and fifteen of chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four, and sections seven, eight, nine and twenty-one of chapter five hundred of the acts of the year eighteen hundred and ninety-seven. The locations granted by this section in, upon or over public ways or lands shall be held by the company or its assigns so long as it or they have the use of the tunnel.

SECT. 12. Upon the completion of the tunnel and appurtenances and upon notification as hereinbefore provided, the company shall remove its elevated trains and cars from the existing subway; and thereupon any alterations therein or in the approaches thereto necessary to readapt it to the use of surface cars shall be made by the commission, and the expense thereof shall be deemed part of the cost of the tunnel. The tunnel during the term of the contract hereinbefore provided for shall be and be considered a part of the elevated railway operated by the company; and the board, subject to the provisions of the contract, shall have and exercise the same power and control over the same in all respects that are conferred upon the board as to the elevated structure by chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four, chapter five hundred of the acts of the year eighteen hundred and ninety-seven and by other laws in addition thereto. The company, upon removal of its elevated trains from the existing subway, may discontinue the use of its elevated structures and locations connecting its elevated road therewith, and may sell any lands or other property acquired for the purposes of such connection, applying all proceeds thereof to proper corporate uses; and such discontinuance or sale shall not be deemed to impair the capital of the company.

SECT. 13. Upon the determination by the commission of any important question arising in the course of the work herein provided for, upon which the company has previously requested a hearing, except an award of or agreement upon damages as provided in section eight hereof, the company may within three days after notice of such determination apply to the board for a revision of the same, and thereupon the board may consider and finally determine such question.

SECT. 14. At any time after the expiration of one year from the completion of the subway the board may order such surface tracks, together with the poles and wires used for the operation of cars thereon, to be removed from any part of Washington street between Broadway and Adams square, except tracks crossing said street, as in its opinion have been rendered unnecessary by the construction of such subway. Such order of the board shall be deemed a revocation of all rights or locations to occupy for street railway purposes the street or part thereof included in the order; and surface tracks shall not thereafter be laid or main-

tained thereon. Nothing in this section contained shall be construed as affecting any existing power to revoke locations on said street or any part thereof as provided by law.

SECT. 15. The use and control of the subway, if acquired by the company, shall be subject to the rights, if any, which the West End Street Railway Company may have under the provisions of article two of its lease to the company, dated December ninth, eighteen hundred and ninety-seven, or otherwise.

SECT. 16. The treasurer of the city shall from time to time, on request of the commission, issue and sell at public or private sale, the bonds of the city, registered or with interest coupons attached, as he may deem best, to an amount not exceeding the cost of the tunnel and subway herein provided for. Such bonds shall be designated on their face, Boston Tunnel and Subway Loan, shall be for such terms, not exceeding fifty years, as the mayor and treasurer of said city may determine, and shall bear interest payable semi-annually at such rate not exceeding four per cent per annum, as the treasurer shall determine. The debts incurred by the city from time to time under the provisions of this act shall not be included in determining the limit of indebtedness of the city as established by law, and the proceeds of such bonds shall be used to meet all damages, costs and expenses incurred by the commission or the city in carrying out the provisions of this act. The board of commissioners of sinking funds shall establish a sinking fund for the payment of the bonds issued under this act. All premiums received from the sale thereof shall be paid into the sinking fund. All rents, tolls, percentages or other annual compensation received by the city for any use of the tunnel or subway under this act, or for any use of any lands or rights taken under authority of this act, shall annually be used by the treasurer, — first, to meet the requirements of and any deficiency in the sinking fund, — second, to meet the interest on the bonds, and the surplus, if any, as a part of the general revenue of the city. The proceeds from any sale of lands or rights taken by purchase or otherwise under authority of this act shall be paid into the sinking fund, or shall be used for construction, as the commission may determine.

SECT. 17. The term of office of the commission is hereby extended to the first day of July in the year nineteen hundred and six. The provisions of section two of chapter three hundred and seventy-five of the acts of the year eighteen hundred and ninety-nine shall remain in force during said extended term. If the term of the commission, as hereby or as hereafter extended, expires before the completion of the work herein provided for, the city shall have all the rights, powers and privileges, and be subject to all the duties, restrictions and liabilities, hereby conferred or imposed upon the commission in respect thereof, such powers to be exercised by the mayor, city engineer and city treasurer in place of the commission, or by such other officers as the city council may prescribe. If this act is not accepted by a majority of the voters of the city, as hereinafter provided, the term of office of the commission shall be extended only to the first day of July in the year nineteen hundred and four. The members of the commission for the extended term provided for in this act shall be appointed by the governor and the mayor of the city in the manner provided in section twenty-three of chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four. Said appointments shall be for the term of two years.

SECT. 18. The supreme judicial court and the superior court, upon application of any party in interest, including the city or any ten taxable inhabitants thereof, may enforce or prevent violation of the provisions of this act by any appropriate process.

SECT. 19. If the contract for the use of the tunnel and subway is

executed by the commission and the company as hereinbefore provided, this act shall be submitted for acceptance to the voters of the city at the next municipal election, and if accepted by a majority of those voting thereon at such election it shall thereupon take full effect. The city shall have, hold and enjoy in its private or proprietary capacity for its own property, the existing subway, the East Boston tunnel, the Cambridge street subway and the tunnel and subway built under this act, and all rents, tolls, income and profits from all contracts heretofore or hereafter entered into for the use of said subways or tunnels or any part thereof, and the same shall never be taken by the Commonwealth except on payment of just compensation: *provided, however*, that so much of such rents, tolls, income and profits as may be necessary therefor shall be paid into the respective sinking funds for the redemption of said bonds and used for the payment of the interest thereon.

SECT. 20. For the purposes of the preliminary work authorized by section two hereof, the payment of the expense of the same, the extension of the term of office of the commission and its powers to the first day of July in the year nineteen hundred and four, the appointment of the members thereof, and the execution of the contract provided for by section ten, and the submission of this act to the voters as hereinbefore provided, this act shall take effect upon its passage. [*Approved June 27, 1902.*]

APPENDIX D.

EMPLOYEES IN THE ENGINEERING DEPARTMENT WHO HAVE WORKED
ONE MONTH OR MORE DURING THE TEN AND ONE-HALF MONTHS
ENDING JUNE 30, 1902.

(Arranged in alphabetical order.)

NAME.	INDICATION OF DUTIES.
BABBITT, JOHN V.,	Assisting in inspection of concrete, etc., Section B.
BATCHELDER, EMMA,	Stenographer.
BELL, DANIEL S.,	Assisting in line and grade work, inspection of concrete, etc., Section C.
BENNETT, ARTHUR F.,	} Inspection of concrete, etc., Section B.
BOWERMAN, FRANK H.,	
BROWN, C. LEONARD,	
CALLINAN, WILLIAM H.,	
CARTER, ARTHUR B.,	
DAVIS, EDMUND S.,	Clerk to the Chief Engineer.
EAGER, FRANK J.,	Oversight of office and field work.
FANCY, CLIFFORD R.,	Inspection of concrete, etc., Sections B and C.
FINNERAN, THOMAS A.,	} Inspection of concrete, etc., Section B.
FLETCHER, FREDERICK W.,	
FOSS, JAMES F.,	Inspection of concrete mixing, Section B.
FRAME, JAMES T.,	Assisting in line and grade work, inspection of concrete, etc., Sections B and C.
HALLETT, NELSON A.,	Testing cement.
HAYES, JAMES B.,	Inspection, Section B.
HILLS, HAROLD F.,	Inspection of concrete, etc., Sections B and C.
HOLMES, ALBERT J.,	Assisting in line and grade work, Section B.
HOLROYD, CLINTON,	Inspection of concrete, etc., Section B.
HOWE, LEONARD B.,	Draughting, etc., in office.
JOHNSON, CHARLES C.,	Testing cement, Sections B and C.
LEWIS, WILLIAM W.,	Designs for structures, draughting, etc.
LORING, LOUIS T. C.,	} Inspection of concrete, etc., Sections B and C.
LOVELAND, CHARLES P.,	
LUCY, ARTHUR E.,	Inspection of concrete, etc., Section B.
MANLEY, LAURENCE B.,	Miscellaneous studies and inspection of work of supporting buildings in State street.
MCCURDY, HARRY S. R.,	Line, grade, and office work.
MCDONALD, FRANK A.,	Assisting in testing cement, Sections B and C.
MURPHY, JEREMIAH L.,	Messenger.
PALMER, JOHN E.,	In charge of construction, Sections B and C.
PERRY, LEON W.,	Assisting in line and grade work.
STEARNS, GEORGE H.,	Designs for structures, draughting, etc.
STILES, FREDERIC W.,	Photography, checking bills, etc.
STREET, L. LEE,	In charge of line and grade work, Sections B and C.
WELLINGTON, WILLIAM O.,	In charge of line and grade work, Section B.

APPENDIX E.

SOME OF THE CONTRACTORS WHO HAVE DONE WORK FOR THE COMMISSION.

ALL EXCEPT THE FIRST-NAMED HAVE DONE WORK AT SOME TIME DURING THE TEN AND ONE-HALF MONTHS ENDING JUNE 30, 1902.

NAME.	CONTRACT.
NATIONAL CONTRACTING Co., New York City. William Mayo Venable, <i>Local Manager</i> . William J. Lang, <i>Superintendent</i> .	Section A of the East Boston tunnel. (Work on Section A was finished November 21, 1900.)
THE BOSTON TUNNEL CONSTRUCTION Co., 23 Lewis St., East Boston. Robert A. Shailer, <i>President</i> . Charles F. Taylor, <i>Treasurer</i> . Principal foremen: Michael Tallent; William McLaughlin; Oscar Jerou until April 4, 1902; and John Boyle from April 4 to June 30.	
GOW AND FOSS, 8 Exchange Pl., Rm. 14, Boston. Principal foremen: A. E. Weaving; Bernard Lewis until the latter part of May, 1902; and James King from the latter part of May to June 30.	Portion of Section C and of Section D.
THE JOHN CAVANAGH & SON BUILDING MOVING Co., 473 Dorchester Ave., South Boston.	Supporting State St. ends of buildings between Commercial St. and Chatham Row.
GEORGE H. FOSS, 8 Exchange Pl., Rm. 14, Boston.	Sewer and manhole in State St., at India St.
JOHN J. FLYNN, 95 Milk St., Boston.	Light frame house over air compressing plant for Section C in India St. in front of the Custom House.
THE INGERSOLL-SERGEANT DRILL Co., Boston.	Air compressing plant for Section C.
GENERAL FIRE EXTINGUISHER Co., Providence, R. I.	Automatic sprinklers and fire extinguisher apparatus in house over Section C air compressing plant.
JOHN Y. MAINLAND, 166 Devonshire St., Boston.	Runway for track and storehouse for cement in State St., at the Custom House, for Sections C and D.

JAMES RUSSELL BOILER WORKS Co., South Boston.	}	Roof shield for Section C.
THE WATSON-STILLMAN CO., New York City.	}	Hydraulic machinery for roof shield, Section C.
THE HODGE BOILER WORKS, East Boston.	}	Three steel air locks for Sec- tion C.
PATRICK MCGOVERN, 57 Maywood St., Roxbury, Mass.	}	Completion of ventilating cham- ber in Hanover St., near Washington St.

APPENDIX F.

PRELIMINARY WORK FOR ATLANTIC CHAMBERS, SECTION B.

Pipe and Sewer Changes. — The pipes, conduits, and sewers, which crossed the area to be occupied by the Atlantic avenue chambers, were moved or relaid outside the location for the chambers. An 8-inch water-pipe was removed and a 12-inch pipe laid on the northerly side of the street. The excavation was done by George H. Foss, contractor, and the pipe was laid by the Water Department, the department paying for the difference in cost for laying a 12-inch pipe instead of relaying the 8-inch. The total length of water-pipe laid was about 187 feet. An 18-inch pipe sewer was cut off and about 180 linear feet of new pipe laid on the southerly side of the street. George H. Foss, contractor, did the work. A 4-inch gas-pipe which lay close to the southerly side of the chambers was temporarily removed by the gas company. A 9-duct conduit of the New England Telephone and Telegraph Company was removed and three 3½-inch temporary iron pipes laid on the southerly side of the street; length about 158 feet. One of these pipes was for the joint use of the Police Signal Service and the Fire Alarm Department. The Postal Telegraph-Cable Company had three 3-inch wrought-iron pipes removed and relocated on the south side; length about 168 feet. One of these pipes was for the use of the Mutual District Messenger Company.

APPENDIX G

PIPE AND SEWER CHANGES REQUIRED NEAR THE SHAFT, FOR SECTION C, AT THE JUNCTION OF STATE AND INDIA STREETS.

	Work done by.	Date.		Length, ft.	Man- holes.	Size.
		Beginning. 1902.	Ending. 1902.			
Sewer	Gow & Foss	Jan. 21	Feb. 11	160	3	2 ft. 2 in. x 3 ft. 3 in. brick and concrete.
Water-pipe	Excavation, Gow & Foss,	Feb. 12	Feb. 16	97	.....	12-in. high service.
	Pipe laying, Water Dept.,	.....	.....	119	.....	16-in. low service.
				118	.....	2-in. low service.
				10	.....	6-in. low service.
Gas pipe.....	Boston Gas Company ..	Feb. 17	Feb. 23	101	Gates. 2	12 in.
Electric con- duits	Postal Tele- graph-Cable Company ..	Feb. 18	Feb. 24	122	Man- holes. 2	4 3-in. iron pipes.
	Edison Elec- tric Ill. Co..	.....	Mar. 21	94	.....	3-in. solid tube.

The sewer and water-pipe changes were made at the expense of the Transit Commission. The changes in the gas-pipe and electric conduits were at the expense of the companies owning the same.

The work of relocating the pipes and conduits in State street at India street, made necessary by the sinking of the shaft, began by changing the sewer, which was a wooden box about two feet square inside. The change consisted of building a 2 ft. 2 in. by 3 ft. 3 in. brick and concrete sewer around the southerly side of the shaft far enough in India street so as not to be interfered with by the operations at the shaft. The easterly end was connected with the existing sewer, which is intended to be replaced by a masonry one at a lower grade after the tunnel is constructed. The westerly end is located so as to connect with the proposed new sewer to be laid on the south side of the tunnel in State

street and is temporarily connected with the existing wooden sewer. This piece of sewer is to be part of the new permanent system. To provide for the house connections on the north side of the shaft temporary iron pipes were laid close to the building foundations, and connected with the existing sewer. The three buildings west of the shaft were connected to one pipe which was carried west of the shaft. The three estates north and east of the shaft were connected to one pipe which was carried east of the shaft.

As soon as the sewer changes were far enough along changes in the water-pipes were begun. These consisted in relaying around the east, south, and west sides of the shaft, as far away as practicable, the 16-inch low-service and 12-inch high-service mains. The service to the buildings was provided by laying a temporary 2-inch iron pipe close to the foundations and connecting the house services with it.

The changes in the gas-pipes followed those in the water-pipe and were very similar, the 12-inch main being carried around south of the shaft, and the service to the buildings being supplied by temporary connections laid close to the buildings made from both the east and west sides of the shaft.

The change in the Edison Electric Illuminating Company's solid tube was made by carrying this tube around north of the shaft close to the building foundations. The service in the conduit line was such that arrangements were made to supply it in other ways and the conduit was taken out. The New England Telephone and Telegraph Company found it convenient to change its service through this part of State street by drawing cables around through Broad and Milk streets to Commercial street. This permitted their present conduit to be cut out. Removing both the Edison and New England ducts thus from this portion of State street lessened considerably the difficulty of rearranging the pipes. The Police Signal Service occupied one of the New England ducts, and arrangements were made to draw their cable around through Broad to Milk street in the New England Company's conduits. The Postal Telegraph-Cable Company relaid its pipes south of the shaft.

The sewer and the Postal Telegraph-Cable Company's pipes are to remain as laid, but all the other pipes and conduits are to be restored as nearly as practicable in their original locations as soon as the work on the tunnel will permit.

APPENDIX H.

ANALYSIS BY PROF. HENRY CARMICHAEL JUNE 23, 1902, OF SAMPLES OF WATER FROM SECTION B OF THE EAST BOSTON TUNNEL TAKEN JUNE 20, 1902, AT STATION 21 + 29 (PUMP WELL), AND STATION 30 + 20 (NORTH DRIFT).

Expressed in parts per million.

	Pump Well.	North Drift.
Total residue on evaporation	642.0	4,024.2 parts.
Organic and volatile matter	98.6	721.4 "
Fixed mineral matter	543.4	3,302.8 "
Chlorine	126.0	1,601.8 "
Calcium sulphate	18.6	345.6 "
Calcium carbonate	37.2	252.6 "
Magnesium carbonate	17.2	104.8 "

APPENDIX I.

CANVASS OF BIDS FOR COMPLETING VENTILATING CHAMBER, SECTION 10, SUBWAY, OCT. 31, 1901.

BIDDERS AND ADDRESSES.	a	c	d	e	f	g	h	i	j	k	Totals.	Time of Beginning.	Time of Completing.
	430 Cu. Yds. Earth Excavation.	60 Cu. Yds. Old Masonry to be Removed.	2 Tons Steel Set in Place and Secured.	70 Cu. Yds. Concrete Masonry, Portland Cement Mortar.	2 Cu. Yds. Brick Masonry, Portland Cem. Mortar.	70 Sq. Yds. Portland Cement Mortar Coating.	160 Sq. Yds. Asphalt.	33 Linear Ft. Granite Curb.	32 Linear Ft. Granite Coping.	Supporting and Protecting Structures.			
Geo. H. Foss, } Boston, Mass. }	\$3 75 1,612 50	\$15 00 900 00	\$25 00 50 00	\$10 00 700 00	\$18 00 36 00	\$0 60 42 00	\$0 75 120 00	\$2 50 87 50	\$1 75 56 00	\$800 00	\$4,404 00	Nov. 11, 1901.	Jan. 11, 1902.
Metropolitan Cont. Co. } Boston, Mass. }	3 50 1,505 00	12 00 720 00	17 00 34 00	10 00 700 00	20 00 40 00	0 50 35 00	0 35 56 00	4 00 140 00	3 75 120 00	50 00	3,400 00	Nov. 4, 1901.	Dec. 9, 1901.
National Cont. Co., } Boston, Mass. }	2 50 1,075 00	6 00 360 00	20 00 40 00	12 00 840 00	18 00 36 00	0 80 56 00	0 30 48 00	2 25 78 75	2 00 64 00	402 25	3,000 00	Nov. 15, 1901.	Dec. 15, 1901.
P. McGovern, } Roxbury, Mass. }	2 25 967 50	9 00 540 00	25 00 50 00	8 50 595 00	15 00 30 00	0 40 28 00	0 40 64 00	3 00 105 00	1 50 48 00	350 00	2,777 50	Nov. 6, 1901.	Dec. 4, 1901.

APPENDIX J.

CANVASS OF BIDS FOR FURNISHING STEEL AND IRON WORK FOR
ATLANTIC AVENUE CHAMBERS, SECTION B OF THE EAST BOSTON
TUNNEL. BIDS OPENED DEC. 10, 1901.

BIDDERS AND ADDRESSES.	About 70 Tons.	
	Price per Ton.	Totals.
G. W. & F. Smith Iron Co., Gerard street, Roxbury, Mass.....	\$75 00	\$5,250 00
Boston Bridge Works, 70 Kilby street, Boston	72 60	5,082 00
American Bridge Co., 89 State street, Boston	69 00	4,830 00
G. P. Bullard & Co., 8 Oliver street, Boston	68 00	4,760 00
Belmont Iron Works, 22d street and Washington avenue, Philadelphia, Penn.	67 00	4,690 00

APPENDIX K.

CANVASS OF BIDS FOR STEEL ROOF SHIELD FOR SECTION C OF THE
EAST BOSTON TUNNEL. BIDS OPENED DEC. 31, 1901.

BIDDERS AND ADDRESSES.	About 62 Tons.	
	Price per Ton.	Totals.
American Bridge Company, Boston, Mass.	\$134 00	\$8,308 00
James Russell Boiler Works Co., South Boston, Mass.	98 50	6,107 00

APPENDIX L.

CANVASS OF BIDS FOR BUILDING ABOUT 170 FEET OF 2 FEET 2 INCHES x 3-FEET 3 INCHES MASONRY SEWER AND 3 MANHOLES
IN STATE STREET NEAR INDIA STREET. BIDS OPENED JAN. 21, 1902.

BIDDERS AND ADDRESSES.	Abt. 450 Cu. Yds. Earth Excavation.	Abt. 25 Cu. Yds. Brick Masonry.	Abt. 10 Cu. Yds. Concrete.	Total.	Time of	
					Beginning.	Finishing.
Collins & Ham, Dorchester, Mass.....	\$7 00 3,150 00	\$22 00 550 00	\$10 00 100 00	\$3,150 00	Jan. 25, 1902.	Mar. 25, 1902.
Metropolitan Contracting Co., 95 Milk st., Boston.....	5 75 2,587 50	15 00 375 00	8 00 80 00	3,042 50	Jan 23, 1902.	Feb. 17, 1902.
D. E. Lynch, Gibson st., Dorchester...	5 00 2,250 00	17 00 425 00	6 50 65 00	2,740 00	Jan. 27, 1902.	Mar. 28, 1902.
Geo. H. Foss, 8 Exchange pl., Boston...	3 00 1,350 00	19 00 475 00	7 00 70 00	1,895 00	Jan. 23, 1902.	Mar. 13, 1902.

APPENDIX M.

CANVASS OF BIDS FOR HYDRAULIC MACHINERY FOR SHIELD NO. 1
FOR SECTION C OF THE EAST BOSTON TUNNEL. BIDS OPENED
JAN. 25, 1902.

THE BOOMER & BOSCHERT PRESS CO., SYRACUSE, N. Y.		THE WATSON-STILLMAN CO., NEW YORK CITY.	
16 jacks at \$325.....	\$5,200 00	16 jacks at \$300.....	\$4,800 00
2 pumps, $8 \times 1\frac{1}{4} \times 7$	920 00	16 plates.....	311 04
Pipings, fittings, valves, gauges, etc,.....	650 00	2 pumps, $8 \times 1\frac{1}{4} \times 7$	700 00
Erection.....	750 00	Valves.....	445 00
	<u>\$7,520 00</u>	Piping and fittings.....	400 00
		Erection.....	<u>850 00</u>
Allowance:			<u>\$7,506 04</u>
For valves, pipes, and fittings used with shield on Section 6 of the Boston Subway \$300 00		\$400 00	
For pump, ditto ...312 50		312 50	
	<u>612 50</u>		<u>712 50</u>
	<u>\$6,907 50</u>		<u>\$6,793 54</u>

Prices for furnishing machinery are F. O. B., Boston.

APPENDIX N.

CANVASS OF BIDS FOR SUPPORTING STATE STREET END OF BUILDINGS BETWEEN COMMERCIAL STREET AND CHATHAM ROW NUMBERED 146-168 STATE STREET. BIDS OPENED JAN. 28, 1902.

BIDDERS AND ADDRESSES.	Amount of Bid.	Time of	
		Beginning.	Completion.
H. P. Cummings Co., 178 Devonshire st., Boston	\$19,800 00	Feb. 1, 1902.	April 1, 1902.
Richard Falvey, Rush st., Somerville.	19,224 00	March 1, 1902.	Aug. 1, 1902.
R. & S. H. Whidden, 43 Milk st., Boston..	16,000 00	Feb. 3, 1902.	April 26, 1902.
Metropolitan Contract- ing Co., 95 Milk st., Boston	15,500 00	Feb. 1, 1902.	April 1, 1902.
G. W. Harvey, 17 Milk street, Boston	13,368 00	As soon as or- dered.	2 months after commence- ment.
Patrick McGovern, 55 Maywood st., Rox- bury	11,000 00	Jan 29, 1902.	April 16, 1902.
John Cavanagh & Son, B'ld'g Moving Co., Boston	10,531 00	3 days after contract is awarded.	45 days after commence- ment.

APPENDIX O.

CANVASS OF BIDS FOR THREE STEEL AIR LOCKS FOR SECTION C OF
THE EAST BOSTON TUNNEL. BIDS OPENED FEB. 18, 1902.

BIDDERS AND ADDRESSES.	About 22 Tons.	
	Price per Ton.	Totals.
James Russell Boiler Works Co., South Boston, Mass.....	\$96 50	\$2,123 00
The Hodge Boiler Works, East Boston, Mass.	96 40	2,120 80

APPENDIX P.

CANVASS OF BIDS, SECTION C, EAST BOSTON TUNNEL, FEB. 25, 1902.

BIDDERS AND ADDRESSES.	a	2a	p	2p	3p	s	b	2b	3b	4b	t	tt	u	2u	Totals Including Items 2a and 3ff.	Totals Omitting Items 2a and 3ff.	Time of Completion If Items 2a and 3ff are Included.	Time of Completion If Items 2a and 3ff are Omitted.	
	14,000 Cu. Yds. Earth Excavation West of Sta. 53 + 67.5.	7,000 Cu. Yds. Earth Excavation in Part of Passenger Station.	Abl. 100 Tons Cast Iron Push Rods and other Iron and Steel except Item 2d, Set in Place and Secured.	Abl. 100 Tons Iron & Steel Tie-Rods & Aperturances (nuts, etc.) & Twisted Rods, set in place, Secured & Painted.	1,000 Cu. Yds. Portland Cem. Concrete with Interior Skin of Mortar W. of Sta. 53 + 67.5.	4,000 Cu. Yds. Portland Cem. Concrete without Interior Skin of Mortar West of Sta. 53 + 67.5.	3,000 Cu. Yds. Portland Cem. Concrete for Portion of Passenger Sta. West of the Atlantic Ave. Chambers.	Putting in Place and Supporting 3 Air Locks, Building Brick Bulkhead around Same, etc.	9,000 Sq. Yds. Coating of Portland Cem. Mortar one-half Inch Thick.	300 Cu. Yds. Grout one part Cement to two parts Sand.	500 Bbls. Portland Cement.	500 Cu. Yds. Fine Sand.	200 Sq. Yds. Waterproof Coating, Prepared and Applied.	3,000 Sq. Yds. Tared Felt, Pitch, etc., Prepared and Applied in 3 or more Layers.	Supporting and Protecting Buildings If Items 2a and 3ff are Included.	Supporting and Protecting Buildings If Items 2a and 3ff are Omitted.			
Patrick McGovern, 57 Maywood st., Roxbury.	\$9,000 126,000	\$13,000 91,000	\$20,000 2,000	\$20,000 2,000	\$30,000 2,000	\$16,000 64,000	\$18,000 54,000	\$4,500	\$0.70 6,300	\$30.00 9,000	\$2.00 1,000	\$0.45 90.00	\$0.25 750	\$90,000	\$60,000	\$481,640	\$306,640	Jan. 1, 1904.	June 1, 1903.
Jones and Meehan, Boston	9.25 129,500	12.00 84,000	18.00 1,800	18.00 1,800	25.00 25,000	15.00 60,000	18.00 54,000	..... 3,000	0.65 5,550	25.00 7,500	2.25 1,125	0.40 80.00	0.30 100,000	60,000	475,555	297,555	Feb. 1, 1904.	July 1, 1903.
Metropolitan Con- tra't'g Co., Bos'n }	9.00 126,000	11.50 80,500	15.00 1,500	15.00 1,500	20.00 20,000	14.00 56,000	16.00 48,000	..... 4,000	0.60 5,400	20.00 6,000	2.25 1,125	0.40 120	80,000	60,000	432,345	283,845	Dec. 1, 1903.	May 1, 1903.
Shaller & Dunfee Co., Boston..... }	8.50 119,000	10.00 70,000	15.00 1,500	15.00 1,500	18.50 18,500	14.50 58,000	17.00 51,000	..... 5,000	0.75 6,750	20.00 6,000	2.00 1,000	0.60 120	75,000	50,000	415,120	269,120	Oct. 1, 1903.	May 15, 1903.

All bids were rejected.

APPENDIX Q.

BIDS FOR FURNISHING, DELIVERING, SETTING UP, AND PUTTING IN OPERATION AIR COMPRESSING PLANT FOR SECTION C OF THE EAST BOSTON TUNNEL. BIDS OPENED MARCH 6, 1902.

BIDDERS AND ADDRESSES.	Amounts.	
	Boiler Capacity.	
	Greater.	Lesser.
The Laidlaw-Dunn-Gordon Co., New York City..... }	\$26,500	\$25,800
Rand Drill Co., New York City.....	21,497	
The Ingersoll-Sergeant Drill Co., Boston, Mass..... }	21,700	20,250

The bid of The Ingersoll-Sergeant Drill Co. for the lesser boiler capacity was accepted. In consideration of being permitted to supply a second-hand compressor and two second-hand receivers the sum of \$20,250 was decreased \$390.

APPENDIX R.

CANVASS OF BIDS FOR FURNISHING MATERIAL FOR AND CONSTRUCTING
A LIGHT FRAME HOUSE OVER AIR COMPRESSING PLANT FOR SEC-
TION C OF THE EAST BOSTON TUNNEL. BIDS OPENED APRIL
15, 1902.

BIDDERS AND ADDRESSES.	Amounts Bid.
F. L. Hodges, 166 Devonshire street, Boston	\$1,656 00
J. Y. Mainland, 166 Devonshire street, Boston.....	1,643 00
J. J. Flynn, 95 Milk street, Boston	1,639 00

APPENDIX S.

CANVASS OF BIDS FOR FURNISHING AND PUTTING IN PLACE SIDEWALK GRATING OVER VENTILATING CHAMBER AT THE NORTHEAST CORNER OF HANOVER AND FRIEND STREETS. BIDS OPENED MAY 29, 1902.

BIDDERS AND ADDRESSES.	Amount.	Time named by Bidder for Completion from Date of Receipt of Order.
L. M. Ham & Co., 150 Portland street, Boston .	\$685 00	About 4 weeks.
American Mason Safety Tread Co., 40 Water street, Boston....	620 00	36 days.
James Flynn, 76 Sudbury street, Boston...	498 50	3 or 4 weeks.

APPENDIX T.

CONCRETE BEAMS 6 IN. X 6 IN. X 30 IN. FOR COMPARING THE STRENGTH
WITH STONE DUST AND WITH SAND, 1902.

Mark.	Wt. of Beam.	Breaking Strength of Beam.	Modulus of Rupture.	Pounds Cement.	Cubic Feet of Plum Island Sand.	Stone Dust.	Cubic Feet of Stone Dust.	Cubic Feet of Broken Stone. (Felsite.)	Average Modulus of Rupture.
1	115.5	3,765	760	380		Medium Size.	9	11	848
2	118.5	3,930	794	"		" "	"	"	
3	119.0	4,665	947	"		" "	"	"	
4	117.5	4,400	892	"		" "	"	"	
5	116.5	4,000	809	"	4	" "	4	12	784
6	114.5	3,495	704	"	"	" "	"	"	
7	121.0	4,180	846	"	"	" "	"	"	
8	116.0	3,830	774	"	"	" "	"	"	
9	119.0	3,830	773	"	7			13	711
10	117.5	3,265	656	"	"			"	
11	118.0	3,680	742	"	"			"	
12	116.0	3,350	674	"	"			"	
13	115.5	3,760	759	"	4	Coarse Size.	4	12	806
14	117.5	4,000	809	"	"	" "	"	"	
15	118.0	4,255	862	"	"	" "	"	"	
16	118.0	3,930	794	"	"	" "	"	"	

The cement used was "Vulcanite." The mixing was done by hand. The beams for the first twenty-four hours were kept in air and were then kept twenty-nine days in damp earth.

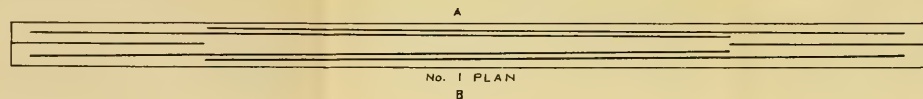
APPENDIX U.

A large number of what may be called concrete briquettes have been made with various American and foreign brands of Portland cement. The following statement refers to some made in the proportion of one part cement, two and one-half parts of fine crushed stone (from impalpable powder up to one-eighth inch diameter), and four parts coarser crushed stone (from one-eighth inch to one-quarter inch diameter) — all by volume. These were kept twenty-four hours in the atmosphere with a temperature of from sixty to eighty degrees F., then in compressed air (eighteen to twenty-five pounds pressure) thirteen days. They were then divided into three lots. One lot was placed in fresh water, one in the sea water (under the harbor), and one remained in the compressed air. The results in the following table refer to the Vulcanite brand, nine briquettes of which (three in each group) were broken each month.

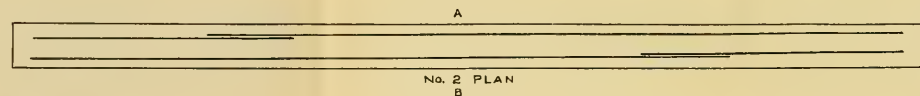
Where the Briquettes have been Kept.	Average Tensile Strength in Pounds per Square Inch at		
	1 Month.	4 Months.	9 Months.
Compressed air (18-25 pounds pressure)....	440	617	866
In fresh water (changed each day).....	460	501	662
In sea water under the harbor.....	420	533	543

The behavior of the other brands of cement mixed in the same proportion has been similar to that of the Vulcanite cement.

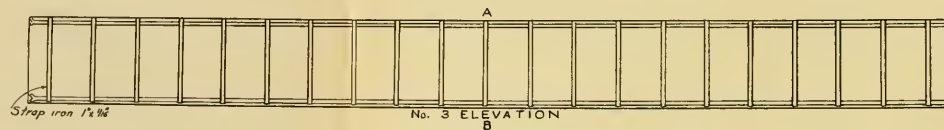
SKETCHES SHOWING HOW THE BEAMS WERE REINFORCED.



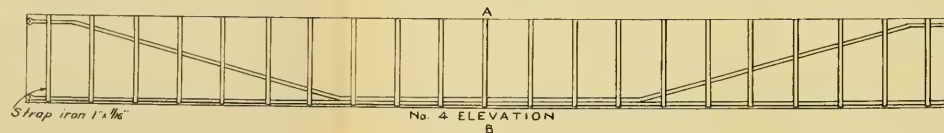
Section A B



Section A B



Section on A B.



Section on A B.

TRANSVERSE STRENGTH
OF
REINFORCED CONCRETE BEAMS.

NO. OF BEAMS.	AGE OF BEAMS WHEN BROKEN.	EQUIVALENT CENTRE LOAD REQUIRED TO BREAK BEAMS, POUNDS.	KIND OF RODS USED.
1	6 weeks.	46000	$\frac{19}{16}$ Twisted Steel
2	" "	34000	" " "
3	8 "	23000	1" Round "
4	" "	42600	1" " "

Cement used, Vulcanite Portland.
Proportions, 1 Bbl. of cement 9 cubic ft. of stone dust and 11 cubic ft. of crushed stone.
Size of beams 21' x 2' x 1'.
Distance between points of support 20 feet.
Load applied at centre of beam.

Scale 1 in. = 2 ft.

APPLIED LOAD. POUNDS.	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
10000	.01			.04		
11000		.03	.03		.04	
13000						.04
20000	.05	.09	.07			.07
21000				.10	.08	
23000					.09	
25000	.09	.11	.10	.14		.10
37000	.19	.20	.22			
43800	.48					
32000	3.90					
28.500		2.72				
28000			1.44			

NO. OF BEAM.	KIND OF COIL USED.	TOTAL RESISTANCE IN POUNDS OF SPLICE.
1	Round wire $\frac{1}{8}$ dia.	32800
2	" "	31900
3	" "	32400
4	Twisted $\frac{3}{16}$ wire	43800
5	" "	40400
6	" "	33000
7	No coil	25100
8	" "	24700
9	" "	24300

Nos. 1, 2, 3, 4, 5, 6.

Wire Coil
5 ins diam.

Concrete.

Concrete.

Cement used, Vulcanite Portland.
Proportions, $1\frac{1}{2}$ Bbls. cement, 9 cubic ft. of stone
dust and 11 cubic ft. of crushed stone.
Age of prism 28 days.
Size of prism $2 \times 6 \times 6$ "
Steel used, Ransoms $\frac{1}{8}$ " twisted rods.

APPENDIX X.

Tests have been made on concrete beams of the same general character as those shown in Appendix A, Seventh Annual Report. All the beams were 6 in. x 6 in., the distance between points of support being 30 in. The concrete was machine mixed. The cement was Vulcanite-Portland. These tests may be summarized in four groups as follows:

Proportions.			Hours in Compressed Air.	Days in Water.	No. of Beams.	Breaking Strength of Beam.			Modulus of Rupture.		
Cement.	Stone Dust.	Broken Stone.				Max.	Min.	Average.	Max.	Min.	Average.
380 lbs.	7.72 cu. ft.	12.36 cu. ft.	24 (7-12 lbs.)	28-30	12	4,915	3,365	4,204	999	677	851
380 "	8.50 "	11.60 "	24 (12-18 lbs.)	28-30	50	4,555	2,950	4,198	924	590	850
380 "	9.08 "	11.00 "	48 (18-25 lbs.)	28-30	30	4,460	3,105	3,626	904	632	731
380 "	9.08 "	11.00 "	28-30 days. (20-25 lbs.)	.....	100	4,440	2,630	3,612	900	523	728

FRAGILE
DO, NOT
PHOTOCOPY

